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Research paper

Patients' admission scheduling techniques and approaches

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Abstract

The aspects of scheduling and optimization are quite prominent in assorted domains whereby the incoming inputs or different type of traffic is processed to the further stage. In traditional ways, there are different approaches including shortest job first, first come first serve, round robin, ranking based and many others by which the overall scoring of inputs is done. In this research manuscript, the scheduling of patients' arrival is addressed that is directly associated with the scheduling of incoming patients to the specific ward or room where that patient is required to be admitted. This work presents assorted approaches for patients' admission scheduling including heuristic and meta-heuristic as well as related perspectives.

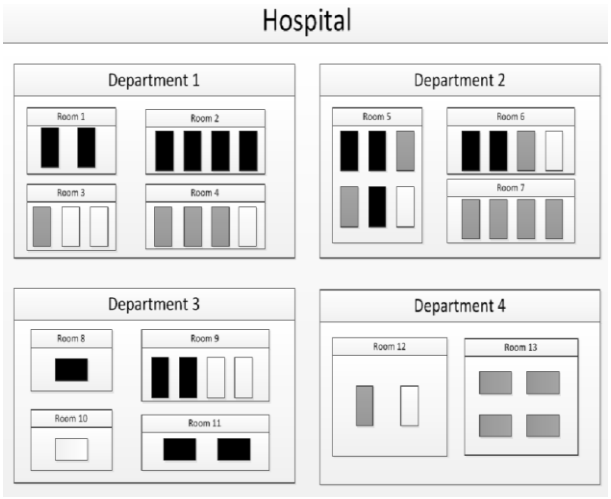
Keywords: *Patient Admission; Patient Admission Scheduling; Patient Arrival Scheduling; Patient Scheduling; Patient Scheduling Optimization Techniques.*

1. Introduction

The patients' arrival is traditionally enormous and random in nature in the hospital having repute and that becomes quite difficult to manage the patients in the existing rooms. There are many aspects and components in the hospital which are required to be executed effectively. The key entities in the hospital include the departments, rooms, specialization and patients.

Arriving Patients and Aspects

1) Fixed Arrivals
2) Requested Treatments
3) Planned Horizon on number of days
4) Preferred Room and Features
5) Room Capacity
6) Room Gender
7) Transfer Rates



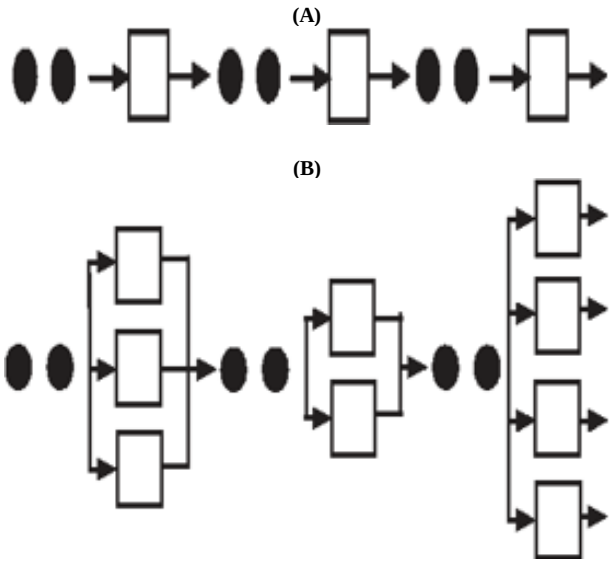


Fig. 1: Traditional Scheduling of Patients with Sequential Approach.

In traditional scenarios, the patients are moved in sequential ways to the wards or by the division of classes of patients on gender or age groups [1].

2. Approaches and techniques for patients' admission scheduling

2.1. Scheduling using genetic algorithm for ophthalmic hospital

As per the work by [2] the scheduling of patients can be done effectively using Genetic Algorithm (GA) [3] that is one of the prominent approaches for optimization with higher degree of ac-

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curacy. This approach is based on the adjustment of weights assigned to each patient so that the fitness level and overall score can be done. This work is having contrast to the traditional First Come First Serve (FCFS) [4] approach for the incoming patients in the treatment panel 2.1. The paper should have the following structure

Following is the comparative evaluation of GA with the traditional approach of FCFS

Estimated Number Of Discharged Patients	The average waiting time for patient admissions		The Preoperative Average Waiting Time of Admitted Patients		Number Of Patients On The Waiting List	Vacancy Rate of Beds
	FCFS	GA	FCFS	GA	FCFS/GA	FCFS/GA
11	6.154	6.308	2.364	2.000	91	100%
12	6.089	6.256	2.333	2.000	90	100%
13	6.022	6.202	2.308	2.000	89	100%
14	5.955	6.102	2.357	2.143	88	100%
15	5.897	6.046	2.333	2.133	87	100%
16	5.837	6.000	2.313	2.125	86	100%
17	5.776	5.929	2.294	2.118	85	100%
18	5.714	5.869	2.333	2.111	84	100%
19	5.651	5.795	2.368	2.158	83	100%
20	5.585	5.720	2.350	2.200	82	100%
21	5.519	5.642	2.333	2.238	81	100%
22	5.450	5.575	2.364	2.273	80	100%
23	5.308	5.504	2.250	2.306	79	100%
24	5.308	5.436	2.375	2.333	78	100%
25	5.247	5.364	2.400	2.360	77	100%

From the presented figures and data analytics, it is evident that the GA based approach is effective as compared to the traditional FCFS. The accuracy level of 100% is achieved in the GA based approach on multiple patients.

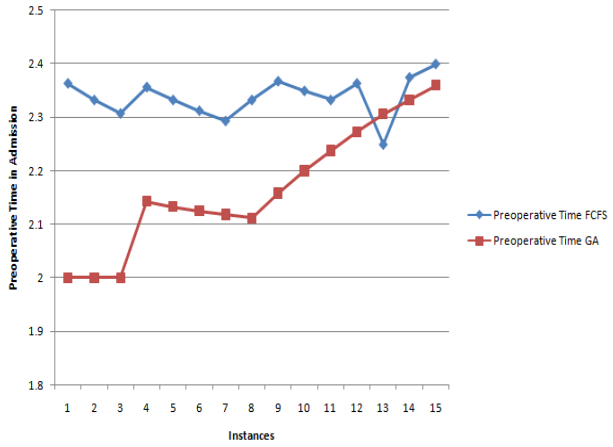


Fig. 2: Comparison of FCFS and GA.

2.2. Agent based scheduling of patients in hospitals

[5] Presents the approach of agents based scheduling whereby the consideration of unplanned arrivals and coordination factors are done. The technique is based on the decision model of agents [6] with OR Scheduling agent with the resource agents. This approach is having key focus on the features of hospital domain along with the priorities based on the disease and the beds. Agent based approach is again very popular and widely used in other domains of research for achieving the higher degree of accuracy and performance.

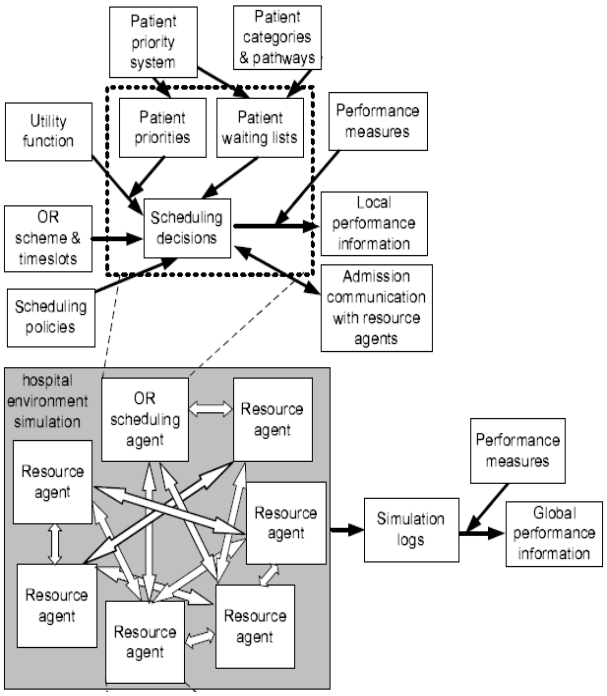


Fig. 3: Patient Scheduling by Agent Based Approach.

2.3. Local search based optimization for patients' scheduling

The work done by [7] presents the approach of simulated annealing in integration with the local search [8] so that the Problem Under Uncertainty (PUC) [9] for Patients' Admission Scheduling (PAC) [10] can be done effectively.

Following are the key points under focus in this technique

- Patient Registration Day
- Uncertain Stay Length
- Patient Admission Shifting

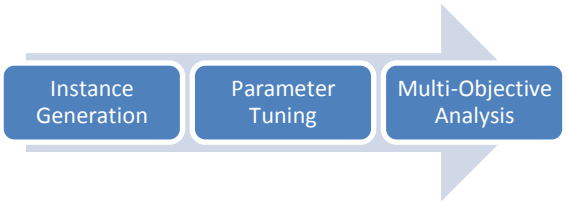


Fig.4: Components in Local Search Based Approach.

The work is having integration of following methods for the optimization

- Instance Generation
- Parameter Tuning
- Multi-Objective Analysis

2.4. Harmony search based technique for scheduling of patients

The work by [11] is having focus on the harmony search [12] with the association of Wheel-Roulette Selection Technique. The proposed approach is having the following aspects and criteria

- Parameter Initialization
- Memory Initialization
- Improvisation with Harmony Vector
- Memory Update

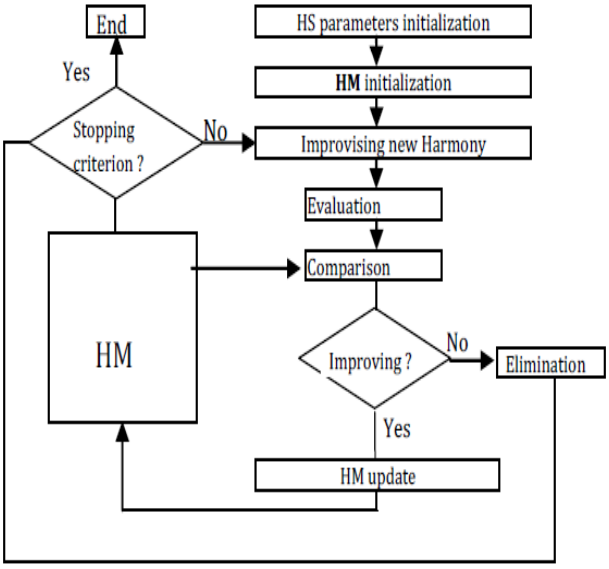


Fig. 5: Flowchart of Harmony Search.

Harmony search based technique makes use of initialization, improvisation, evaluation and final comparison of the results so that the elimination of results and final acceptance of outcome can be done.

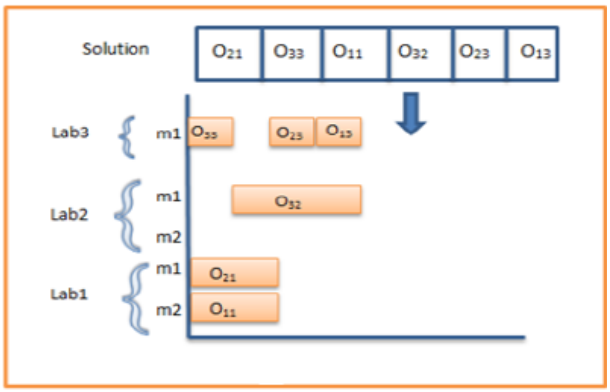


Fig. 6: Representation of Labs and the Patients with Allocation of Rooms.

Table 1: Processing Time in the Laboratories with Real Emergency Instances

Laboratory	Processing time(s)	Number of places
Blood Analysis (BA)	360	4
Scanner	480	3
Radiology	600	2
Magnetic Resonance Imaging (MRI)	1800	1
Electrocardiography (ECG)	240	2
Urinalysis (UA)	300	3

2.5. Column generation technique

This technique by [13] presents the inclusion of heuristic based approach for optimization on patients' admission scheduling. In this technique, the dynamic aggregation procedure is adopted for the improvements in the traditional algorithms of scheduling. This technique is an iterative process in the pricing and master problems having assorted set of solutions and can be further enhanced.

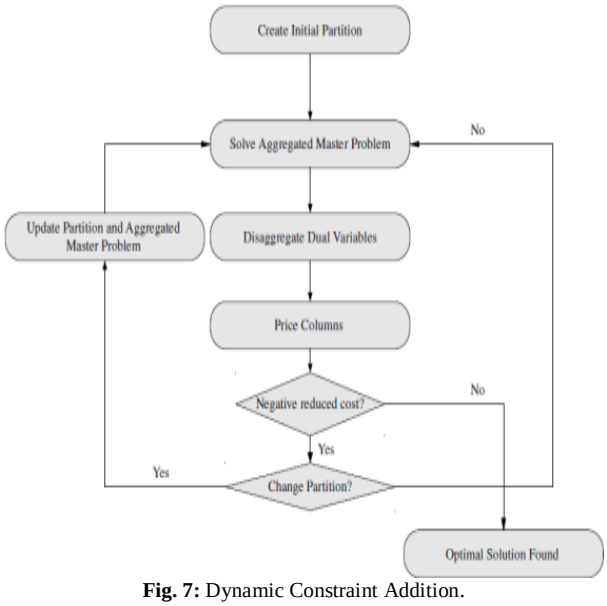


Fig. 7: Dynamic Constraint Addition.

In this approach, the partitioning is implemented and set up of different thresholds are done. This technique makes use of objective function and the constraints for the optimization.

2.6. Adaptive non-linear based approach

The work by [14] presents the use of meta-heuristic approach for patients-admission optimization problem. The work is based on the setup of mathematical model with the hard and soft constraints. The work focuses on the updating of water level adaptively while addressing the patient admission problem.

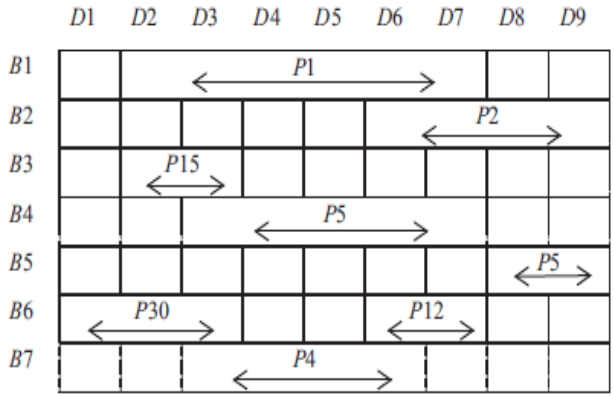


Fig. 8: Allocation of Beds to Patients in Specific Timeslots.

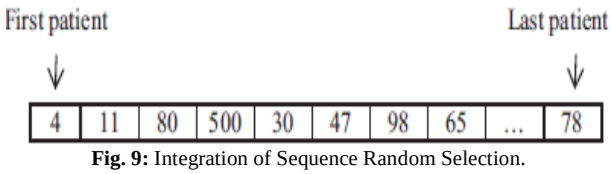


Fig. 9: Integration of Sequence Random Selection.

2.7. Hyper heuristic based approach

The approach is presented by [15] with the key elements of wards, timeslots, patients and rooms. The patients' preferences are considered in the work so that the satisfaction level can be achieved on hard and soft constraints. The objective function is having the weight factor so that any violation can be avoided. The work presents the integration of simulated annealing so that the overall performance can be elevated

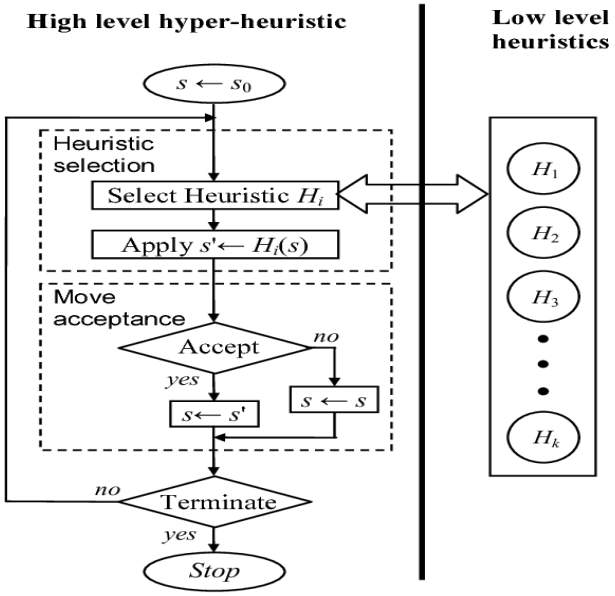


Fig. 10: Hyperactive Heuristic Based Approach for PAS.

2.8. Multi-neighborhood based approach

The work by [16] devise the approach of multi-neighborhood based local search for the optimization of patients' scheduling. The work integrates the cost function and initial solution for further optimization with the neighborhood solutions and relations with the perspectives of Change Room (CR) and Swap Room (SR). The approach is found effective on multiple parameters.

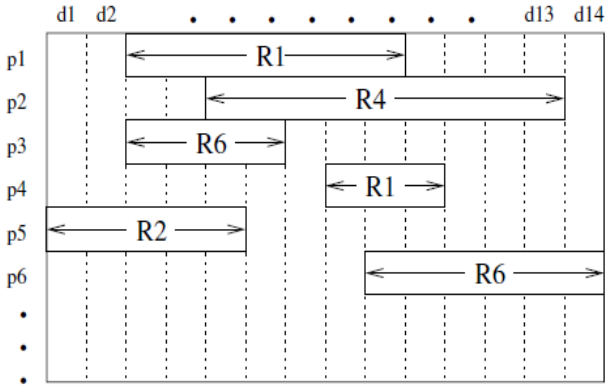


Fig. 11: Entire Search Space with D-Day and R Rooms.

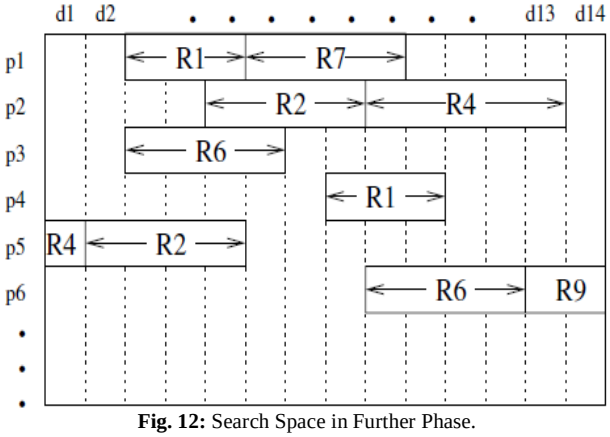


Fig. 12: Search Space in Further Phase.

2.9. Hybrid tabu search based optimization of patients' scheduling

[17] Implements the hybrization based tabu search for the scheduling and optimization of patients' assignment. The work is compared with the traditional integer programming that is not found effective as compared to the proposed approach. The solutions presented with the two dimensional matrix with the allocation of beds and the patients so that the overall assignment can be done effectively.

2.10. Biogeography based approach for optimization

The work by [18] presents that the BBO or Biogeography based Optimization can be used for the scheduling of patients with the key idea of evaluation of species migration. The work includes the use of two dimensional matrix with the cells on allocation factors of beds to the patients. The algorithm of BBO analyzes the neighborhood structures and the solution vectors for optimization.

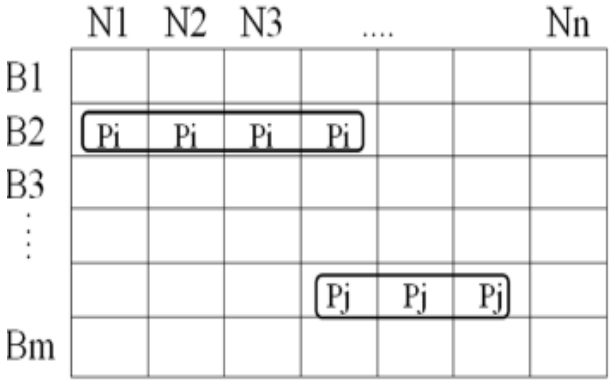


Fig. 13: Solution Matrix with Beds and Allocation to Patients.

2.11. Case study based evolutionary approach for patients' scheduling

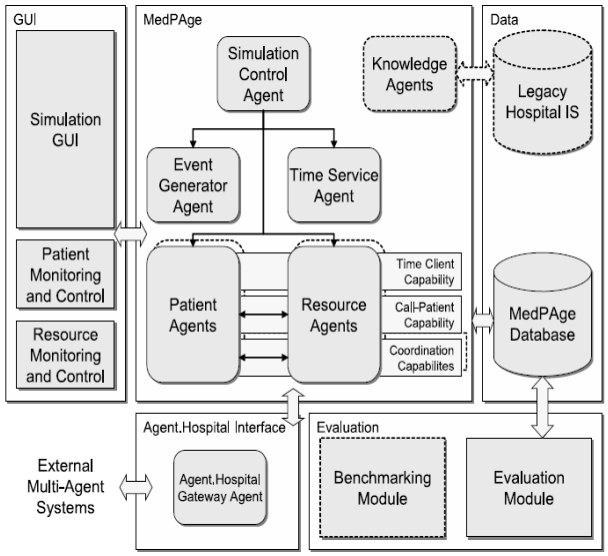
The work by [19] presents the use of genetic algorithm with the evolutionary approach for the solution to scheduling of patients. The work reduces the waiting time to higher extent and improves the efficiency parameter. The work integrates the genetic operators with the timetabling algorithm for the escalation of effectiveness.

2.12. Late acceptance hill claiming based approach

The work by [20] presents the effectivenss of late acceptance hill climing approach with the integration of room oriented approach or ROP for the scheduling of patients. The proposed LHAC approach is depicted better as compared to the traditional PAS approach.

2.13. Dynamic approach for scheduling of patients in hospital

[21] depicts the use of multi-agent system MedPAge (Medical Path Agents) for achieving the higher degree of accuracy and performance in the scheduling of patients. The presented model consist of knowledge agents, legacy hospital IS and the interconnecting channels.



2.14. Operating room constraint based approach

The work by [7] is having key focus on the extension to the patients' scheduling using local search based approach in association with complex neighborhood structures and the operators. The solution approach is having the integration of simulated annealing for the threshold and fitness values of the allocation.

2.15. Mixed integer programming based approach with heuristics

The approach by [22] presents the use of mixed integer programming for the optimization of PAS. Here, PAS is presented as the complex as as well as combinatorial optimization problem whereby the patients' allocation is a quite huge complex job. The proposed approach integrates the Fix Relax (FR) and Fix Optimize (FO) based approach for the overall optimization of the PAS problem.

3. Conclusion

The patients' admission scheduling is one of the prominent issues that need effective algorithms so that the incoming patients can be given swift service without delay and congestion in the hospital. In this manuscript, the assorted approaches and techniques for the optimization and scheduling of patients is presented. The work is having

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