

Graph theoretic solution to the Nurse Shifts Allocation Problem in Multispecialty Hospitals

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Abstract

In Multispecialty hospitals, nurses play key role for smooth functioning of activities of hospital. Being multispecialty hospital, there are number of departments with different requirements and expertise. It is a tedious task to allocate available nurses among shifts based on different parameters. Hospital management needs to be very careful while allocation of nurses so that no shift remain unassigned and no nurse remain unallocated. Various parameters are considered for the same. This allocation can be done with the help of Bipartite Graph, as it is having two sets and each node in one set adjacent with node in other set. In this paper, researchers consider six parameters viz; shift time, change in ward, Critical area, (ICU, OT), Experience, Qualification, and number of beds available in hospital as one set. In another set is containing nodes representing requirements of hospital. The allocation are made on the basis of above defined attributes of nurses. This problem is solved with the help of novice algorithm designed by researcher applying assignment problem solving algorithms and Maximum matching algorithm.

Keyword :Assignment Problem, Bipartite Graph, Graph Theory, Nurse Shift Allocation, Maximum matching algorithm.

1. INTRODUCTION

Human Resource Management is study of managing employees in the organization. The responsibilities of human resource manager are staff allocation, employee compensation and defining work[1]. As Edward L. Gubman observed in the *Journal of Business Strategy*, "the basic mission of human resources will always be to acquire, develop, and retain talent; align the workforce with the business; and be an excellent contributor to the business. Those three challenges will never change." . Resource allocation is process of allocating available resources to different jobs, services. This allocation is based on concept that maximize utilization of resources. These resources must be utilized in such a way that maximum output should be received. These resources are limited. To overcome this problem, concept of rationing emerged. Rationing refers to limiting the consumption of resources to meet the demand. [2]

There are various allocation strategies that can be used by organization to maximum utilization of resources. One of commonly used strategy is equal allocation of resources among duties or jobs. Another strategy is allocation of resources as per need. This strategy is used in health care, resources are allocated as per criticality of patient condition or as per requirement of respective department. Rationing comes into picture when resources are limited and demand is high. Here, resources are allocated on First-Come, First-Serve mechanism. The department or job who demands the resources first will be allocated first. In health care industry, if there is scarcity of nurses, they are allotted double shifts or increase in working hours to achieve maximum utilization so that all departments will work smoothly.

When resources are limited, allocating resources as per requirement is best option. For instance, allocating nurses to department where there is scarcity is best option.[2]. An optimal resource allocation in health care is critical process as nurses' work in shifts. According to Employee Task Management Problem, allocating all nurses to duties in such a way that no nurse remain unassigned and no duty is unallocated.

2. GRAPH THEORY

Graph is a mathematical structure used to model pair wise relations between objects. A "graph" in this context is made up of "vertices" or "nodes" and lines called edges that connect them. A graph may be undirected, meaning that there is no distinction between the two vertices associated with each edge, or its edges may be directed from one vertex to another. Graphs are one of the prime objects of study in discrete mathematics. In the most common sense of the term a graph is an ordered pair $G=(V,E)$ comprising a set of vertices or nodes together with a set of edges or lines, which are 2-element subsets of (i.e., an edge is related with two vertices, and the relation is represented as an unordered pair of the vertices with respect to the particular edge).[3]

2.1 BIPARTITE GRAPH

Formally, a graph $G = (V, E)$ is bipartite if and only if its vertex set V can be partitioned into two non-empty subsets X and Y , such that every edge in E has one endpoint in X and the other endpoint in Y . This partition of vertices is also known as bi-partition. [4]

A matching in a Bipartite Graph is a set of the edges chosen in such a way that no two edges share an endpoint. A maximum matching is a matching of maximum size (maximum number of edges). In a maximum matching, if any edge is added to it, it is no longer a matching. There can be more than one maximum matching for a given Bipartite Graph.[5]

3. ASSIGNMENT PROBLEM

The assignment problem (AP) is a discrete and combinatorial problem where agents are assigned to perform tasks for efficiency maximization or cost (time) minimization. AP is a part of human resource project management (HRPM). The AP optimization model, with deterministic parameters describing agent-task performance, can be easily solved, but it is characteristic of standard, well-known projects realized in a quiet environment. When considering new (innovation or innovative) projects or projects performed in very turbulent times, the parameter estimation becomes more complex [6]

4. ALLOCATION OF DUTIES TO NURSES IN MULTISPECIALITY HOSPITAL

Normally, Job Allocation Problem (JSP) considered as allocation of available jobs/duties equally among available employees. While allocation of these jobs, they are allocated in such a way that maximizing efficiency or productivity with minimizing cost or/and time. In multispeciality hospitals, there are different types of departments with requirement of specialized skills. Hospital authority expect high level of dedication and efficiency from their staff, this field directly deal with human lives. Therefore, while allocating duties, hospital authority should take care to allocate equal duties according requirements of various wards and departments in hospital. In duty allocation of nurses, instead of allocating duties equally, duties will be allocated as per need of department or ward. Therefore, in health care sector, assigning jobs/duties to nurses is tedious task. Nurse Superintendent and Hospital Management needs to take care of various factors while allocating duties to nurses. There are n number of requirements of hospital and different number of nurses in each hospital. These number of nurses and requirements of hospital may vary time to time due to various causes like suddenly increase in number of patients, trained nurse left the job, nurses wants change in shifts or wards, demands by doctors for specific skilled nurse. In this paper, researcher considers six parameters/ requirements by hospital while allocation of duties to nurses as *shift time, wards/departments available, requirements in critical areas in hospital like OT, ICU, Number of beds in hospital, Experience, and qualification*. These parameters are tested or coordinate with number of nurses available. To represent this allocation, researcher uses Bipartite Graph and try to solve this problem using matching technique. Here, requirements for duty allocation are considered in one set (R) and in other set consist of available nurses in hospital(N).

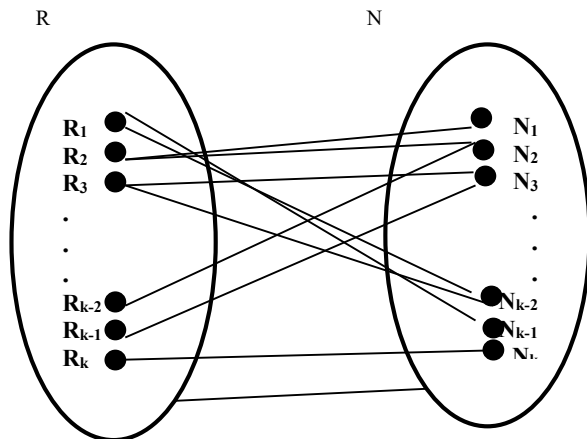


Fig : Parameters against nurses

With the help of bipartite graph, researcher wants to represent that, duty allocation can be done on the basis of available resources and requirements of that day. Sometime one or two requirements are satisfied by one or two nurses or we can also say that due to scarcity of nurses extra duties allocated to available nurses. To represent above graph, researcher uses assignment problem solution and represent above matching in form of matrix. In this matrix, R represents rows for hospital requirements and N shows number is nurses in columns. 0 denotes not matching element whereas 1 denotes matching requirements with nurses.

	N ₁	N ₂	N ₃	N _{k-2}	N _{k-1}	N _k
R ₁	1	0	1	0	0	0
R ₂	0	1	0	1	1	1
R ₃	0	0	1	1	0	1
R _{k-2}	1	0	0	1	0	1
R _{k-1}	0	0	0	1	1	0
R _k	1	1	1	1	1	1

5. CONCLUSION

In this paper, researcher represented the concept of nurses duty allocation in multispeciality hospitals, where number of departments and requirements of each department is different. Hospital management need to allocate duties in such a way that no requirement is unassigned and no nurse is not remain unassigned. This allocation is expected to be minimize cost and time and maximize profit. Researcher is going to develop algorithm for this allocation which represent mapping in two set of bipartite graph in matrix.

6. REFERENCES

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