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Iso-Resource Grouping for Acute Health Care in Australia: A Global Optimization Approach

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In this paper we suggest the *concept of iso-resource grouping* as a powerful tool for classification of patients in Australian *acute health care* sector. In order to implement this concept and demonstrate its power in action, *cluster analysis* approach based both on the methods of *convex* and *global optimization* is deployed. Classification and grouping of patients into defined categories or hierarchies using clinical data is difficult in acute care settings (Ridley et al, 1998). The supervised assignment of elements of a given set into groups or clusters of like points, is the objective of *cluster analysis*, and, therefore, there exists a natural motivation and enough potential interest to *apply cluster analysis to iso-resource grouping in acute care*. There is a number of approaches to cluster analysis, including statistical (Jain and Dubes, 1988), machine learning (Fisher, 1987), mathematical programming, and *k*-median (Mangasarian, 1997). In this paper the *global optimization* approach suggested by Bagirov et al (1999) is utilized to determine the centers of clusters. This approach is based on *cutting angle method* for global optimization developed and recently modified by Bagirov and Rubinov (2000). In this study the *influence of simple demographic data* about the patient usually available at admission to emergency department *on patient's length of stay* is explored using global optimization based clustering analysis. Over twelve thousand patients admitted to one of Victorian acute care hospitals were classified into groups with similar patterns of length of stay and resource consumption. Then, the role of the patients' diagnostic codes on their resource consumption is analyzed and its implications for patients' management are addressed.

Classification and grouping of patients into categories using clinical data is a difficult management task. The existing clinical methods such as the International Classification of Disease (ICD-10AM, 1992) are designed to be used in all areas of health care and usually rely on subjective coding of clinical conditions or diagnoses. However, this may not be appropriate for emergency and intensive care units since their mix of patients may be more diverse than that of other hospital departments. The wide ranges of age, severities of illness, comorbidities, and diagnoses may confound a simple classification system that requires one predominant underlying condition. Furthermore, diagnostic grouping is not equivalent to *grouping patients according to resource consumption (iso-resource grouping)*. This issue is at the core foundation of capacity and utilization planning for acute care facilities throughout Australia. Diagnostic groups may be markedly heterogeneous with respect to treatment costs and clinical resources utilized. For example, the diagnosis of bacterial pneumonia could involve a brief admission with a short period of mechanical ventilation or could entail several weeks of support for multiple organ failure (Ridley et al, 1998).

In an attempt to predict, measure, and then allocate hospital costs, patients need to be grouped according to their levels of resource consumption. At present, measurement of resource consumption in acute care settings is fraught with difficulties. Various sources argue that the *patient's length of stay* may be the best currently available *proxy for resource consumption*

(Ridley et al, 1998; Cropper and Forte, 1997). The **objective** of this study is firstly to explore whether the global optimization based clustering approach to iso-resource grouping could efficiently partition acute care patients into groups with similar length of stay using only simple demographic data available at admission to emergency department and, secondly, to analyze the relationship between Diagnosis Related Groups (DRGs) generated by using ICD classification and iso-resource groups obtained as the result of cluster analysis.

As far as existing approaches to this topic are concerned, the CART-based analysis by Ridley et al (1998) has to be mentioned. Ridley et al (1998) use classification and regression trees to partition the workload in intensive care unit into homogenious and mutually exclusive iso-resource groups. CART-based analysis of this problem assumes certain subjectivity in establishing bounds for partitioning, which, in turn, influences the final results. We believe that by using precise global optimization based algorithms (Bagirov and Rubinov, 2000) for cluster analysis and by utilizing different set of patients' data more appropriate to Australian settings, we are able to produce less restrictive and more methodologically motivated analysis for successful resource planning and management within acute care hospital.

From the theoretical point of view the global optimization methods provide the best solution for determining centers of clusters. We have to note, though, that both storage and time requirements are strongly dependent on the dimension of the problem, and the segmentation of very long sequences might not be practically feasible. In such situations various heuristics have been used (Bagirov et al, 1999). In the simplest cases well known methods of convex optimization can be used allowing the user to solve high dimensional problems with reasonable accuracy. In this paper, the special problem of convex programming is addressed. The analysis of this problem allows to separate the most important decision variables as far as determination of clusters is concerned, which are, in turn, used for more precise determination of cluster points. The later is achieved by using so-called *cutting angle method* (Bagirov and Rubinov, 2000) of global optimization.

The data set used to test the proposed approach is presented by over 12,000 records of patients addmitted to one of the acute care hospitals in Victoria. After appropriate scaling procedure being applied to it, each record includes 15 numerical fields representing a variety of patient's demographic data, ambulance/emergency related parameters, diagnostic grouping, and the length of stay both in emergency department and in hospital at large. The final analysis and recommendation stage involves cross-analysis of patients groups, understanding the role of the patients' diagnostic codes on their resource consumption, and its implications for patients' management and capacity planning decisions.

Main References:

1. Bagirov, A.M. and Rubinov, A.M. (2000). Cutting angle method in global optimization: theoretical and numerical analysis. Research Report No 8, School of Information Technology and mathematical Sciences, University of Ballarat.
2. Bagirov, A.M., Rubinov, A.M., Stranieri, A., and Yearwood, J. (1999). The global optimization approach to clustering analysis. Research Report No 45, School of Information Technology and mathematical Sciences, University of Ballarat.
3. Cropper, S. and Forte, P. (1997) Enhancing Health Services Management. Open University Press.
4. ICD-10 (1992) – World Health Organization. Manual of the International Classification of Disease, Injury, and Causes of Death. 10th edition, Geneva: World Health Organization.
5. Ridley, S., Jones, S., Shahani, A., Brampton, W., Nielsen, M., and Rowan, K. (1998). Classification Trees. Anaesthesia, 53, pp.833-840.