

MODELLING OF CLINICAL RISK GROUPS (CRGs) CLASSIFICATION USING FAM

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ABSTRACT

Clinical Risk Groups (CRGs) are a clinical model in which each individual is assigned to a single mutually exclusive risk group which relates the historical clinical and demographic characteristics of individuals to the amount and type of resources that individual will consume in the future [1]. CRGs based risk adjustment system is a potential risks adjustment to be used in the capitation-based payment system, a budgetary system for healthcare resource and care management [1, 2, 3]. The purpose of CRGs is to provide a conceptual and operational means through diagnosis and procedure code information routinely available from claims and encounter records. Basically, CRGs classifies patient population by presents of chronic health condition, type of chronic health condition, severity of chronic health condition and presence of significant acute health condition. Fuzzy ARTMAP (FAM) is an incremental supervised learning of recognition neural networks in response to input and target pattern [4, 5]. FAM is a fast learning algorithm and used less epoch training [4]. Based on its performance in doing the classification, FAM is theoretically suitable to do the CRGs classification. This paper views CRGs clinical logic and the data elements focus on identification of CRGs features using FAM. Previous studies (in USA and Canada) used claimed base data such Medicare, Medicaid and private insurance provider data for few years back. Some of the material use in this paper is based on research proposal titled, "Development Of Clinical Risk Groups - Based Intelligent System For Future Prediction Of Health Care Utilization And Resources" by UKM CRGs researchers and KUKUM AI Embedded researchers.

Keywords

Classification, Fuzzy ARTMAP, Data Model, Clinical Risk Groups, Risk adjustment, Capitation Based Payment and Health Care Management.

1. INTRODUCTION

The shift towards capitation based payment system in the healthcare management in many countries is to overcome the problem of limiting the growth in spending the health services while ensuring the efficiency of the health services to the population. [1, 2, 3, 8] Capitation based payment systems is healthcare payment system based on total per capita member, and the whole prospective budget of the healthcare are allocated in advance. [9]

In country like United States and Canada the use of risk adjustment to manage their healthcare industry is common. The

objective of risk adjustment is to help ensure the budgetary allocations and healthcare provider assessments take into account the morbidity of individual patient.

Clinical Risk Groups (CRGs) are a clinical model in which each individual is assigned to a single mutually exclusive risk group which relates the historical clinical and demographic characteristics of individuals to the amount and type of resources that individual will consume in the future, have the potential to provide risk adjustment for capitation payment system.[1] This is because CRGs has link to between the clinical and financial aspect of care where CRGs provide a means of incorporating the clinical characteristics of individuals into the determination of the payment amount. Some of previous risk adjustment only taking statistical formula in calculating the payment weights into consideration, actually the critical factors in the success of the capitation based system and the healthcare management are the clinical module and the payment weights. [1, 8]

CRGs are designed to serve as the foundation of management systems which support care pathways, product line management and case management. The CRGs were developed to include explicit severity of illness subclasses that describe the extent and progression of an individual's condition. This can then be used to project healthcare need and its resources of the community. For policy makers and top level management, this tool can be use as a decision support system for an efficient strategic management of future healthcare services and financing.

Many works showed that neural network make better generalization. The use of neural network is unlimited and good in classification, modeling forecasting and novelty detection [9]. In application such as control, tracking and prediction system, classifiers is used to determine the input output relationship [7]. Fuzzy ARTMAP is a member of the class of neural network architectures referred to ART architectures has neural network classifier, that satisfy most of the classifier properties mention in [7]. This paper is try to describe the CRGs logic and its data element. How it can be presented in the Fuzzy ARTMAP algorithm that will predict the healthcare budget and healthcare resources.

This study is still in the beginning stage, this paper will overview the CRGs based payment system concept and data element. Briefly we will discuss how the methodology, approach and data will be use in the study.

2. CHARACTERISTIC OF A CRG-BASED PAYMENT SYSTEM

The development of classification for risk adjustment must address how risk adjustment is integrate into each payment system and should address the full payment system as a whole. The system must be viewed as part of an overall system for monitoring and evaluating the Managed Care Organizations (MCOs) performance [1]. Basically, the full payment system will have a large number of categories and the categories can be aggregated. CRG Grouper will able to assign each person to a mutually exclusive diagnosis category and return all diagnostic and procedures (any medical procedures done) recorded during the time period [14]. Figure 1 is describing the full CRGs based payment system as a whole.

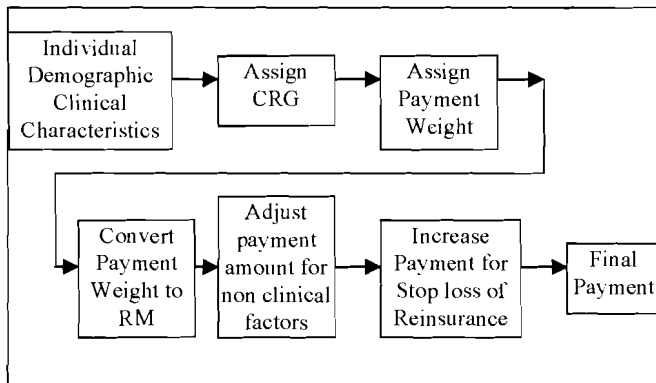


Figure 1: The CRG Payment System [1]

The first part of our studies will concentrate on the first three steps of the CRGs payment based system. Implementing Fuzzy ARTMAP to assign CRGs and assign payment weight.

2.1 The CRGs clinical logic

The detail CRGs clinical logic is described in [1, 3]. Here we would like to briefly view how the process of assigning CRG to individual or patient.

The ICD-9CM, defines a standard diagnosis code (disease code) and a standard procedure code (treatment code).

Basically, the important element of CRGs model is there are nine cores of health status group, catastrophic, metastatic malignancy, chronic triplet, multiple significant chronic pair, single dominant/chronic dominant, multiple minor chronic pair, single minor chronic pair, significant acute and healthy [1, 8, 14].

First of all and individual disease profile and history of pass medical intervention. CRGs assign each diagnosis code to major diagnostic categories (MDCs). Each of MDCs further categorized and refer as Episode Disease Categories. Each EDCs will be assign to one of six EDC types refer to dominant chronic (DC), Moderate Chronic (MC) and Minor Chronic (C), Chronic Manifestation (CM), Significant Acute (SA) and Minor Acute [1, 8].

Each of EDCs the primary chronic disease (PCDs) identified and within each PCDs established its severity levels. Individual with at least one chronic disease the PCDs is the most significant chronic disease within the MDCs and assign the severity level.

Individual with more than one chronic disease, the most highly rank EDCs is selected as PCD. Once PCD and the severity level determine for each MDC with chronic disease, the individual is assigned to one of the nine core health status rank. Within core health status, individual are assign to a base CRG which then stratified into severity levels and becomes the final CRG. Individual without chronic disease diagnosis, have no PCDs, are assigned to core health status 1 "Healthy" if they have no significant sign of acute diagnosis in the pass certain period of time e.g six months. Those with significant acute diagnosis in the pass certain period of time, are assigned to status 2 "History of significant acute disease [8].

2.2 The CRGs Data Elements

Most of the current studies on CRGs use claimed data for several years. Data for the current studied year is use to predict the next year of healthcare budget. Basically there are four set of data elements are required in implementing CRGs. 1) Enrolee descriptor or registered profile. 2) Diagnose data 3) Procedure data and 4) Resource data [14]. The first three sets of data elements are important and required to classify the individuals while the last data element is important for predicting the health resources use in every level of total of resource use.

3. THE FUZZY ARTMAP NEURAL NETWORK

A detailed description of the fuzzy ARTMAP neural network describe in [4, 5]. Here we would like to briefly view the fuzzy ARTMAP neural network. The fuzzy ARTMAP neural network consists of two fuzzy ART modules, designated ART_a and ART_b , as well as an inter-ART module as shown as below.

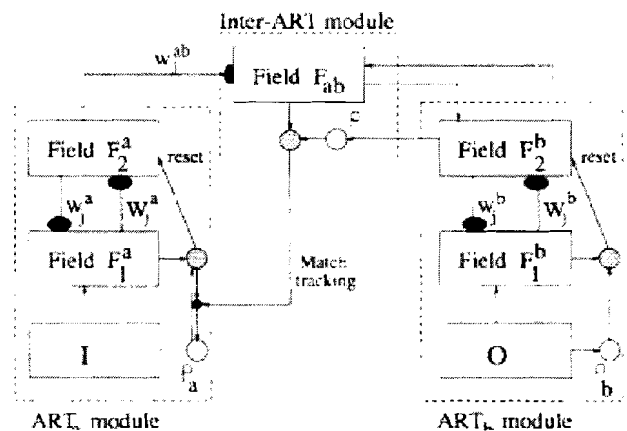


Figure 2: A block diagram of the fuzzy ARTMAP neural-network architecture.

Inputs are presented at the ART module, while their corresponding outputs are presented at the ART module. The inter-ART module includes a MAP field whose purpose is to determine whether the correct input-output mapping has been established. The input pattern, designated by I has the form

$$I = (a, a^c) = (a_1, \dots, a_{M_a}, a_1^c, \dots, a_{M_a}^c)$$

where

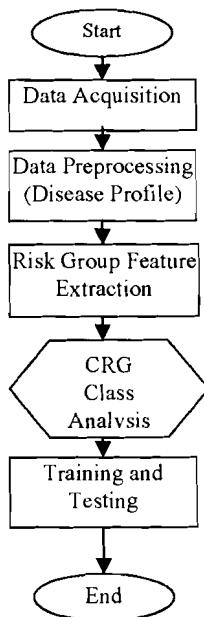
$$a_i \in [0, 1] \quad \text{and} \quad a_i^c = 1 - a_i; \quad 1 \leq i \leq M_a. \quad (1)$$

The output pattern, designated by , has the form

$$\mathbf{O} = (b_1, \dots, b_{M_b}) \quad \text{where} \quad b_k \in [0, 1]; \quad 1 \leq k \leq M_b. \quad (2)$$

Fuzzy ARTMAP operates in two distinct phases: the *training phase* and the *performance phase*. The *training phase* of fuzzy ARTMAP works as follows: Given a list of training input–output pairs, such as $\{I, O\}, \dots, \{I^1, O^1\}, \dots, \{I^{PT}, O^{PT}\}$, we want to train fuzzy ARTMAP to map every input pattern of the training list to its corresponding output pattern. In order to achieve the goal, we present the training list repeatedly to the Fuzzy ARTMAP architecture. That is we present I^1 to ART_a and O^1 to ART_b , then I^2 to ART_a and O^2 to ART_b , go on until finally I^{PT} to ART_a and O^{PT} to ART_b . The training list is presented as many times as it is necessary for fuzzy ARTMAP to correctly classify all the input patterns. The classification task is considered accomplished (i.e., learning is complete) when the weights do not change during a list presentation. The *performance phase* occurs when the trained fuzzy ARTMAP network is used to classify a list of test input patterns.

4. METHOD AND APPROACH



4.1 Data Acquisition

Population data done by a group of researchers from UKM lead by Prof. Dr Syed Muhammad Aljunid, the one that will be used to develop the CRGs clinical model. The study is still in on going status. The description of the population data is based on the study done by the UKM researchers, a group of experience medical doctors. Two years of data period will be used.

The study population will be carried out in 3 states i.e Kedah, Selangor and Johor. A multiphase sampling method will be carried out where by two districts in each state will be chosen to represent urban and rural district. The classification of urban and rural are based on the Statistic Department of Malaysia definitions. In each district 600 houses will be chosen based on Statistic Department of Malaysia calculation. (Enumeration blocks (EB) / living quarters (LQ) calculation). The sampling unit is including the entire household’s members including all children till adults. All types of diseases or mental illness will be taken into account as they will represent the healthcare utilization and their resources that they will acquire in the next two years of study. Exclusion criteria are those who refuse to participate in the study.

4.1.1 Sample Size

The total sample size for this study is 18,000 respondents. The respondents will represent the classification of 500 Major Diagnostic Category (MDCs) of diseases. The total number of diseases from the respondents are based on the assumption of average visit per respondent to Primary Health Care is six times per year and percentage of admission is 5.0% (Annual Report 2003, Ministry of Health).

The 18,000 respondents will be selected from 6 districts using multistage sampling method. Each district requires the total of 3,000 respondents or 600 household, assuming 5 members per household.

4.2 Data Preprocessing

Individual data profile will be created. Convert all raw data into computerize data. Here data cleaning and data formatting will be done. Data mining technique could be considered. All disease codes use to form the MDCs shall be defined. Obtain the link of characteristic in further categorized the MDCs into EDCs. Establish the EDCs types to use. Then obtain the link in identifying PCD. Recognize the health status of the profile belong to and establish the severity level. Lastly assign the final CRG to the profile or individual.

5. Discussion and Conclusion

CRG clinical logic is very complicated and exhaustive. Numerous data files and observation involved in developing it. Based on studies done by [1,8,14] more than thousand categories or classes or cells developed. This study is expected to do 1081 classification of CRGs or cells or categories.

Few hurdles are expected during the data collection. In this research the instruments and tools will be used are set of questionnaire and Health Dairy for the respondents. Thus data inaccuracy and incompleteness are expected. Thus a well trained interviewer shall be considered to do the interview.

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