DESIGN OF A MEDICAL DATABASE TRANSFORMATION ALGORITHM

Karine Abbas[(1)], Christine Verdier[(2)], André Flory[(1)]
Lyon Research Center for Images and Intelligent Information System
UMR 5205 CNRS/ INSA of Lyon[(1)], University Claude Bernard Lyon1, University Lumière Lyon 2[(2)],
Ecole Centrale of Lyon Bat. Nautibus, 43 bld du 11 Novembre 1918, F 69622 Villeurbanne cedex

Keywords: Medical record structure, database reverse engineering, database transformation algorithm.

Abstract: The aim of this article is to create a unique medical record structure from the metabase of any medical record. The work proposes the design of transformation algorithms which consists in translating the legacy relational database (RDB) into a unique medical record structure by analysing the correlation between the legacy RDB keys and the classification of the relations into four types : base relation, dependent relation, inheritance relation and composite relation.

1 INTRODUCTION

The medical record consists in collecting health events corresponding to patient's lifelong. Medical data are of different types: laboratory test results, radiology reports, diseases, etc. These data come from many places: physician practices, hospitals, nursing facilities, etc. Consequently, for each type of data and care place, a medical information system can have its own medical record structure. Dealing with various record structures requires much effort and time. Creating a unique medical record structure becomes a primordial requirement. In this context, our approach proposes to transform any medical record towards a unique medical record structure.

Thus, the aim of our research is the design of a technique that ensures facility to extract hidden semantics embedded within database relations and efficiently to rebuild medical record's structure. This paper proposes the design of a medical database transformation algorithm. This methodology allows for

- Restructuring the physical schema by using the data dictionary (métabase).
- Extracting a semantic description in each relation.
- Analysing of the correlation between primary keys and foreign keys.

This article is organized as follows. Section 2 presents related works. Section 3 describes the principle of our reengineering technique by outlining the database transformation algorithm. Finally, section 5 concludes with our future work.

2 RELATED WORK

Many database reverse engineering works have been proposed. (Chiang 1994) proposed an approach which determines the regular and weak entities, derives many-to-many and one-to-many relationships, establishes generalisation hierarchies and proceeds to the classification of relations, attributes and their inclusion dependences.

Other works (Anderson 1994), (Petit 1995) based on query/view analysis have been investigated. These approaches analyse query language statements.

The method MERCI (Lammari 2001) suggests a technique in three stages: 1) extract the physical schema by using the data dictionary 2) design a conceptual schema in the entity / relation form by identifying entities, relationships, generalizations, etc. 3) research hidden semantics embedded within programs and data.

(Tari 1997) proposes a method which identifies the relational schema in three categories: base, dependent and composite relations, and translates these relations into object-oriented schema by analyzing the degree of correlation between the keys of relations and the degree of correlation between the tuples of the relations.

Abbas K., Verdier C. and Flory A. (2006).
DESIGN OF A MEDICAL DATABASE TRANSFORMATION ALGORITHM.
In *Proceedings of the Eighth International Conference on Enterprise Information Systems - DISI*, pages 335-339
DOI: 10.5220/0002466703350339

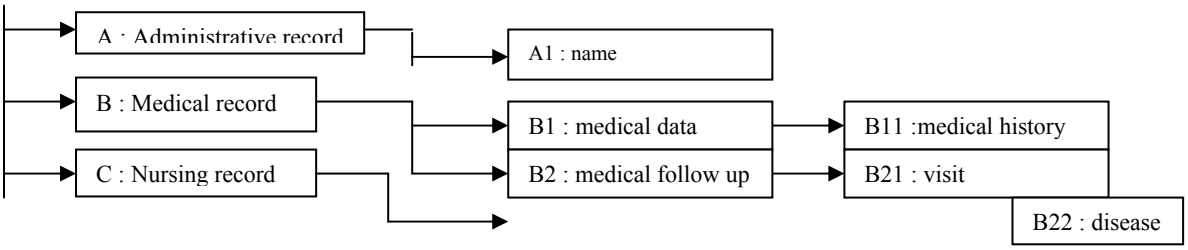


Figure 1: Medical record structure.

3 DESIGN OF THE UNIQUE MEDICAL RECORD STRUCTURE

A medical record contains information about an individual's lifetime health care. All medical information about a patient is confidential and accessible only for authorized persons (doctors, nurses, etc.) involved in the care of the patient. Defining access rules for medical data protection is an important aspect. However, with the different medical record structures, designing an access policies system is a difficult process. That's why having a unique medical record's structure becomes an essential requirement. In this context, we propose a transformation algorithm of any medical record towards a unique medical record structure. This algorithm restores the database physical schema and generates a unique medical record's structure.

3.1 Unique Medical Record Structure Description

The medical record's structure can be represented in an oriented graph. Nodes contain medical terms and arcs represent relationships between terms. Figure 1 represents the medical record architecture. The first level manages four medical terms: administrative record, medical record, nursing record and emergency record. These terms are fixed. However, the terms inserted into the nodes starting from level 2 are modifiable and depend on information contained in the database schema.

3.2 Medical Reference Model

A medical reference model represents the most elements used in the care places. This includes concepts and terms for medical record components. The terms of the reference model are used to be compared with data retrieved from the database physical schema.

In level 1, This medical record model is composed as follows: A) Administrative record, B) Medical record, C) Nursing care, D) Emergency

A list of similar or synonymic words corresponding to each element of the medical record is proposed. For generating this list, we use ontology systems as UMLS, HL7, CEN TC 215. For example the term "surgery visit" can be represented by "surgery consultation", etc.

3.3 Design Technique of the Unique Medical Record Structure

We propose a technique which consists in analysing the information embedded within a relational database. The physical schema is generated across different relational databases' data. Then, relations are classified in four types: base relations, dependent relations, composite relations and inheritance relations.

Our technique mainly consists in two stages : I) The first one analyzes the correlation between relation keys. II) The second stage generates the record structure.

3.3.1 Key Correlation Analysis

In the section, we analyse the correlation between primary and foreign keys of the relations. Three cases are identified: 1) relation does not contain foreign keys, 2) foreign key is a component or not of a composite primary key, 3) foreign key is equal to the primary key.

This section describes key correlation analysis stages:

1) The program retrieves all relations of the relational database. This operation uses SQL which interrogates the data dictionary and return back the names of tables, primary keys and foreign keys.

2) Then, we fetch the relations which concern the patient's care.

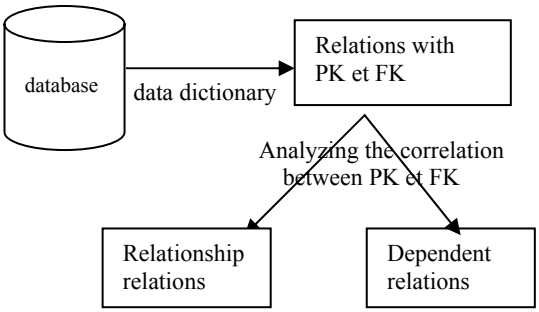


Figure 2: Key correlation analysis.

- Look for the relation that identifies the patient. This stage can be executed by comparing the names of relations with the "Patient" word or its synonyms. The relation “Patient” will be the starting point
- Traverse the physical schema : i) We analyze the correlation between the primary keys and the foreign keys of the relations.ii) We classify the relations in two groups: composite and dependent relations

The stop point is a relation of the type n-m. We explain this by giving a example:
visit (**num**, #num_patient, #num_med_resp)
prescript (**#num_visit, #num_drug**)
drug (**num**, #num_ther_class)
therapeutic_class (**num**)

The relation between “visit” and “Patient” is represented with binary association. Thus, we take in consideration the relation ”visit”.

The relation between “visit” and “drug” is represented with n-area association. Thus we do not take in consideration the relation “drug” and we stop our processing because if we do, we take in consideration the relation “therapeutic_class”. This relation contains data that not provide any information about the patient.

The algorithm1 proposes to realize the two previous stages. The dependent relations are expressed as follows : {visit} for th erelation “Visit”. But for the composite relation “Prescriptions”, this is represented in this way: {prescriptions: visit + Medicine}.

Algorithm 1

```
Input : L_Tab : relations with primary
and foreign keys
Output : L1 : composite relations,
         L : dependent relations

T = table_patient(L_Tab)
L = L ∪ T
For L_tab ∈ L do
  For Tab ∈ L_Tab do
    if  FK of Tab ⊆ PK of L_tab then
     if Pk of Tab ⊄ FK || PK of Tab
       then L_ent=L_ent∪{Tab(L_tab)}
            L = L ∪ {Tab}
       If  PK of Tab ⊆ FK of Tab then
        L_assoc = L_assoc ∪ {Tab}
   End for
End for
```

Example 1 : We propose a example of relational schema. After the application of SQL queries on the data dictionary, we obtain this information.
Person (**num**)
Patient (#**num** , #num_doctor)
Visit (**num**, #num_patient, #num_doct)
doctor (**num**)
Prescriptions (**#num_visit, #num_drug**)
Drug (**num**, #num_thera_class)
Disease (**num**)
Disease_profile (**#num_visit, #num_disease**)

After applying the algorithm1, we have
List_entit = {visit}
List_assoc = { disease_profile = Visit+Disease,
Prescriptions= Visit +Drug }

3.3.1.1 Patient’s Relation Analysis

Here, we analyze the relation “Patient”. Two data of the relation “patient” are to be taken in consideration: 1) non key attributes 2) foreign keys.
1) The non key attributes are added into the administrative record of the medical record’s structure.
2) The second case provides information from the tables which depend of the relation “Patient ”. In the phase, we test two possibilities: 1) If the primary key is also a foreing key 2) If there are foreign keys other than the primary key.

- The first possibility allows to find the superclass of the relation “Patient”.
- In the second possibility, we retrieve the names of relations that depend on the relation “Patient”.

Algorithm 2

```
Input :relation « Patient »
Output:L_pat :depend of patient L_inh :
superclass relations

FK = Analyser (Patient).
For X ∈ FK do
 if X est PK then
  L_inh=L_inh ∪ {name_superclasse}
```

```
 Else
  L_Pat=L_pat∪{name_FK : name_table)
End for
```

Example 2:
In the relation Patient (#**num**, #num_doctor), we have : PK = num. and FK = num_doctor.
Thus **List_Pat** = {num_doctor : doctor}

The attribut "num" is also FK of the relation "Person". Result **list_inh** = {Person}.

3.3.2 Constitution of the Structure

After building the two lists (dependent list and composite list), we start inserting the elements of these two lists in the medical record structure. We begin with the dependent relations. The first point to be realized is to compare every element of this list with the data of the reference model of the patient's record. If the element is found, it is added to the structure. Otherwise a synonym for this word is proposed. If it is found, we insert the element into the structure. Otherwise, we add it in the list of the unclassified words to classify them later manually.

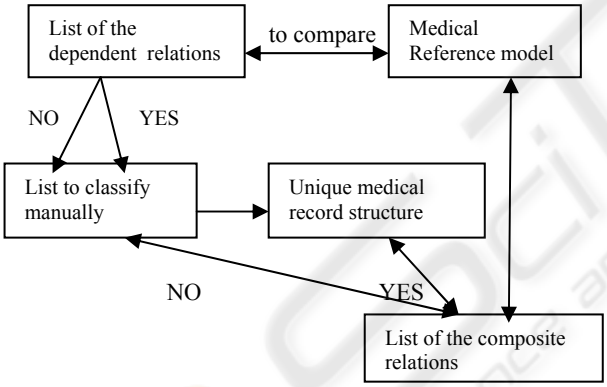


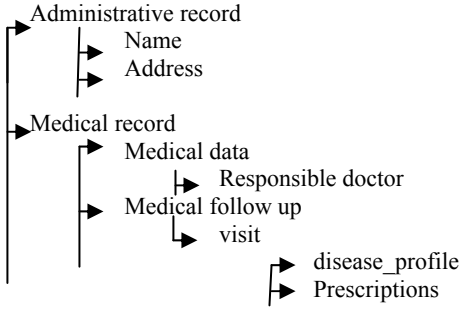
Figure 3: Reconstitution of the structure.

Now, we deal with the list of composite relations. We remind that every element is represented as follows: A= B+C (A represents the name of the relationship relation, B and C the base relations). We begin first by comparing "A" to the list of elements constituting the reference model of the medical record. If it is found, we insert "A" into the structure. If not, we look for a synonym for "A". If it is found, we insert this synonym into the structure. Otherwise we compare B and C. If it is found, the synonym is inserted into the structure.

```
Algorithm 3
Input :L_entit : dependent relations,
       L_assoc : composite relations
       L_Pat : depend Relation patient
       L_inh : patient relation
             inherite
Output :unique medical record structure
// dependent relations
For L_ent ∈ L_entit do
  L_ent = Tab (tab_dep)
  If tab ∈ Modèle()
    Inser(tab)
  Else L_no_find = l_no_find ∪ Tab
End do
// composite relations
For L_ass ∈ L_assoc do
  L_ass = attribA = tableB+tableC
  If attribA ∈ Modèle()
   Insert(attribA, tableB)
  Else if
  Attribn = Rech_syno(tableB,tableC)
    Insert (attribn, tableB)
  Else L_no_find = l_no_find ∪ L_assos
End do
// liste Liste_pat
For L_pati ∈ L_Pat do
  L_pati = attrib:name_tab
  If attrib ∈ Modèle()
    Insert(attrib)
  Else if
    Attribu = Rech_syno (Name_tab)
    Insert (attribu)
  Else L_no_find = l_no_find ∪ L_pat
End do
// inheritance relations
For L_inher ∈ L_inh do
       Insert(Find_attribute(L_inher))
End do
```

Example 3: We have four lists
L_entit = {visit (patient)}
L_assoc = { Disease_profile = Visit+Disease,
Prescriptions= Visit +Drug }
L_Pat = {num_doctor : doctor}
L_inh = {Person}

After applying the algorithm3, we have the following structure :



4 CONCLUSION

In this article, we have presented a technique which creates a unique medical record's structure. This technique proposes algorithms which be developed in JAVA. The unique medical structure record's structure is represented in XML language. This structure will be used later in our future works for managing access control in a medical system.

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