

An Expert Case-Based System using Decision Tree Induction for Weight Management Counseling To Obese Children

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ABSTRACT

Case based Reasoning (CBR) has become very popular AI technique. It is based on the assumption that problems can be solved efficiently by reusing knowledge about similar stored problems.

Obesity actually represents an excessive storage of energy as fat relative to the lean body mass. Childhood Obesity is a major international problem. Obesity is associated with many medical problems, most of which improve with weight loss.

In previous paper, the Nearest Neighborhood algorithm was applied on distributed case bases for Case retrieval and Case adaptation.

In this paper, we have used the Case Based Reasoning (CBR) methodology to develop a case-based expert system for counseling of obese children using decision tree induction.

Our future work will include implementing the CBR module and comparison of various machine-learning techniques, such as neural networks, genetic algorithms and so forth.

1 INTRODUCTION

Obesity is a complex, multi-factorial chronic disease involving environmental (social and cultural), genetic, physiologic, metabolic, behavioral and psychological components. Poor dietary habits and lack of physical activity are reported contributors to the increase of obesity in youth. Healthy eating and regular physical activity are important for acquiring and maintaining good health. Proper counseling on nutrition and appropriate physical activity targeted at primary and early secondary school children can control the problem of obesity.

In previous paper, we discussed about A Case-Based Expert System for Weight Management Counseling (ECB-DTWMC) for obese children to understand how their dietary and activity lifestyle influences their health, using Euclidean distance [7].

CBR is a problem-solving technique that uses past experiences to

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find a solution. It is quite simple to implement in general, but it often handles complex and unstructured decision making problems very effectively [2].

In this paper, we propose an Expert Case-Based System using Decision Tree Induction for Weight Management Counseling (ECB-DTWMC) that uses CBR methodology for providing Weight Management Counseling to Obesity problem.

In section 2, we present an introduction to Obesity and Weight Management followed by an introduction to CBR i.e. reviews of related work. Section 3 describes the system architecture. In section 4, we detail our proposed expert system. Our plan for future work is presented in section 5.

2 LITERATURE REVIEW

Obesity And Weight Management Counseling

Obesity is defined as an excessive accumulation of body fat. Childhood obesity has multiple causes around an imbalance between energy in (calories obtained from food) and energy out (calories expended in the basal metabolic rate and physical activity). Childhood obesity is the leading cause of Pediatric hypertension, Type II diabetes mellitus, Increase the risk of coronary heart disease, Lower self-esteem, Respiratory problem, Deficiency in Vitamin A, Vitamin D, Iron & Calcium and Early Death.

Three major theories of obesity are: -

- Insufficient energy expenditure** - Obese individual actually has a higher RMR (Resting Metabolic Rate) than a normal weight people.
- Dietary factors** - When humans eat diets high in fat, excess body fat is formed more easily than with the high carbohydrate, high fiber diet.
- Genetic and parental influences** - The risk of obesity is more if both parents of the child are obese.

Table 1. Prevalence and Treatment of obesity

Type	Classification of Obesity		
	Mild	Mode -rate	Severe
% Overweight	41-100%	20-40%	>100%
Sample Weight	168-196 lb	197-280	>200lb

		lb	
Prevalence	90.5%	9.0 %	0.5%
Treatment	Behavior therapy, (Diet,exercise, Behavior modification)	VLCD and Behavior therapy	Gastric Surgery

Decision Tree

Decision tree analysis has long been used when a multi-stage decision process is involved. Some recent examples are mentioned in [1].

While there may be many approaches to developing such an expert system, the use of decision tree analysis is proposed and its application to this example problem will be demonstrated.

Case Based Reasoning

Case based Reasoning (CBR) is an approach for solving a new problem by remembering a previous similar situation and by reusing information and knowledge of that situation (Aamodt & Plaza, 1994). This concept assumes that similar problems have similar solutions. A general CBR cycle is described by the following four processes by Aamodt & Plaza (1994) (see Figure 1).

1. RETRIEVE the most similar case(s).
2. REUSE the information and knowledge
3. REVISE the proposed solution.
4. RETAIN the parts of this experience likely to be useful for future problem-solving.

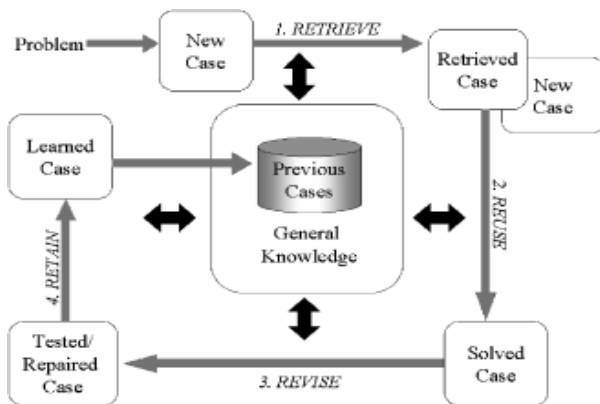


Figure 1: CBR cycle by Aamodt and Plaza

3 SYSTEM ARCHITECTURE

This article integrates DM and CBR techniques for Weight Management Counseling. The goal of integrating CBR and decision theory is to improve the ability of CBR systems to solve problems on domains of incomplete information. The system architecture of ECB-DTWMC is shown in Figure 2.

The architecture of ECB-DTWMC (Figure 2) system includes two phases: a knowledge management module and Case Based Reasoning Module.

In the Knowledge Management Module, the relevant data sets are collected for data mining. The data sets then undergo cleaning and preprocessing for removing discrepancies and inconsistencies to improve its quality. The decision tree induction algorithm or case association algorithm is deployed to mine out the association rules.

In the Case Based Reasoning Module, inputting a new case of obese child will trigger the ECB-DTWMC system for weight management counseling to obese children by using the rules discovered in knowledge management module. Then, the reasoning of the CBR mechanism will be started to seek the most similar case of the new case for supporting counseling.

4 MODULES OF CASE-BASED EXPERT SYSTEM FOR WEIGHT MANAGEMENT COUNSELING

The Case-Based Expert System comprises of following Modules:

4.1 Knowledge Management Module-

This module includes following components: -

4.1.1 Data Repository- The data repository consists of the domain knowledge in Weight Management Counseling, which comprises of BMI chart, expert advice, etc.

4.1.2 Knowledge Miner –It is responsible for extracting weight management knowledge using data mining tools from the heterogeneous data sources. In CBR systems, the case-base is analyzed by an induction algorithm that produces a decision tree for classifying cases. The most widely used induction algorithm in CBR is called ID3, that builds a decision tree from a database of cases.

The decision tree induction algorithm is applied to find the weight management rules.

In the Knowledge Management Module, critical fields of the data sets are selected as the mining fields. The selected dataset is analyzed that represent relationships among data by applying the decision tree induction.

4.1.3 Case Based Rule Structure- The Case bases are the repository representing the collection of obesity and weight management knowledge, which are used by the case builder to automatically create new Case Bases for Weight Management Counseling.

4.2 Case Based Reasoning Module

In the Case based reasoning module, the Case Builder is the main component. The reasoning procedure of Case Builder is listed below:-

4.2.1. Input New Case - Input a new case data of obese child, which will trigger ECB-DTWMC system to seek the most similar case of the new case.

4.2.2. Assign Index Weight- From the decision trees, ECB-DTWMC system will extract rules and weights according to the thresholds that are set up by the users or experts.

4.2.3. Case Retrieval - Our methodology views the retrieval of old cases in CBR as decision problem, where each case from the case base provides an alternative solution & a prediction of possible outcomes for the problem.

Consider the new case described in Table 3. By using Inductive Learning technique, the solution for new case is S2 which is derived from the decision tree shown in Figure 2.

4.2.4. Case Adaptation - The purpose of case adaptation is to modify the retrieved case to solve the problems of the new case.

4.2.6. Revise Case - When the solutions of the new case are not suitable for the new case, revisions can be conducted.

4.2.7. Save Case - Save the case into case base to enhance the completeness and to consolidate the self-learning mechanism of the system.

5 FUTURE WORK

Our future work will include implementing the weight management counseling module and building the interfaces to allow interactions between the system, domain experts and end users.

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Figure 2: The architecture of ECB-DTWMC system

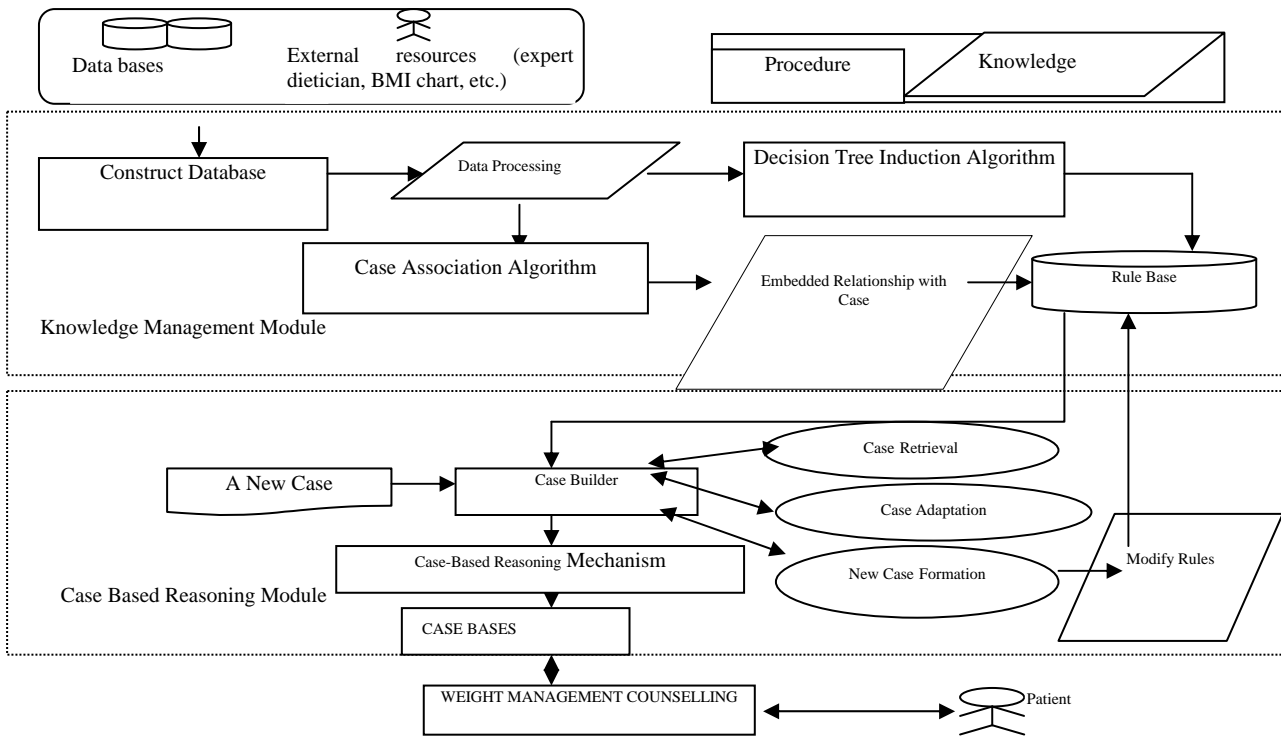


Table 2. CASE DATA

Case	Diet	Food type	Physical Activity	Family	Exercise	Suggestion
C2	Overeating	Fatty Food	Indoor	Both	Regular	S2
C5	Overeating	Fatty Food	Outdoor Regular	Both	No	S1,S2
C9	Overeating	Fatty Food	Outdoor Regular	Both	Regular	S2
C10	Overeating	Normal Food	Indoor	Both	No	S1,S2
C12	Overeating	Normal Food	Outdoor Irregular	Both	No	S4
C14	Normal	Normal Food	Outdoor Irregular	Both	Regular	S3
C18	Overeating	Normal Food	Outdoor Regular	Both	Regular	S2
C23	Overeating	Fatty Food	Outdoor Irregular	Mother	Irregular	S4
C27	Overeating	Fatty Food	Outdoor Regular	Mother	Regular	S2
C29	Overeating	Normal Food	Indoor	Mother	Irregular	S4
C35	Overeating	Normal Food	Outdoor Regular	Mother	Irregular	S4
C38	Overeating	Fatty Food	Indoor	Father	Irregular	S4
C47	Overeating	Normal Food	Indoor	Father	Irregular	S4
C54	Normal	Normal Food	Outdoor Regular	Father	Regular	S3
C69	Overeating	Normal Food	Outdoor Irregular	Noone	Regular	S2
C73	Normal	Fatty Food	Outdoor Regular	Mother	Irregular	S2
C85	Normal	Fatty Food	Outdoor Irregular	Mother	No	S4
C88	Balanced	Normal Food	Outdoor Irregular	Both	Regular	S3
C96	Balanced	Normal Food	Indoor	Both	No	S1
C100	Balanced	Fatty Food	Outdoor Regular	Noone	Regular	S2
C new	Balanced	Normal Food	Outdoor Regular	Mother	Regular	?

Figure 3. The classification tree for obesity

