

# US Dental Insurance Company Database

Group #36

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## A. Requirement Analysis

### I. Introduction

Risk, cost analysis, and market development are all key issues for any insurance company. This application will focus on the myriad of data needed for a typical dental insurance company to be able to analyze and build models to increase its profitability. By analyzing critical factors such as cost, profit, and demographics, a dental insurance company can determine which customers it wishes to target, what prices to set for its plans, and many other business decisions which will ultimately impact the company and all the people who depend on it for dental insurance coverage.

The scope of this application will be limited to dental insurance policies within the U.S. This includes both government-based insurance plans (i.e. Medicaid and Medicare) as well as private, commercial insurance plans.

## II. Data Requirement and Description

### Entities and their attributes

#### Claims

A claim is submitted by a member (see below) to the insurance company after completing a dental procedure. It is identified by a unique primary key, the claim ID, and includes three foreign keys: member ID, provider ID, and plan ID, and has other attributes: procedure code, total cost, co-pay cost, insurance pay cost, and date.

#### Members

A member is someone who has purchased a dental plan with the company. Members are identified by their unique primary key, member ID, and includes the foreign key plan ID and other essential attributes: first name, last name, gender, age, race, address, what state they live in, income, and membership tenure (number of months since becoming a member).

#### Plans

A plan summarizes the key information for a specific insurance policy, which includes type (whether government-based or commercial), member fee, number of members in the plan, plan profitability, and is identified by a unique primary key, plan ID.

#### Providers

A provider is a dentist who is in a plan's network. Members can only submit claims from dental procedures done by a provider. The provider is identified by its unique primary key, the provider ID, and includes first name, last name, specialty (e.g. general practitioner, dental surgeon, orthodontist, etc.), experience (in years), the average member cost of the provider (the total amount of insurance money paid to the provider divided by the number of members who visited that provider), and the average member profit (the average membership fee minus the average member cost).

### Dental Offices

A dental office is a group of one or more providers who work at a specific location together. It is identified by its unique primary key, location ID, and has an address, the state the office belongs to, average member cost (the sum of the average member costs of all the providers who work in this office), and average member profit (similarly the sum of the providers' average member profits).

### Demographics

Demographics are general population information for each state used to predict the average dental costs needed by a resident of the state. Demographics are identified by the unique primary key state name and records the population size, population density, racial shares, and average household income.

### Member dental medical history

A member's dental medical history is a weak entity that details all of a member's previous dental procedures. It is defined by a combination of the foreign key member ID and the date of the procedure, and includes the procedure code and cost as well.

## Relationships

### visits

A member visits a dental office. This is a many-to-many relationship, since members are free to visit any dental office they wish, and dental offices can accept multiple members.

### works\_at

A provider works at a dental office. This is a many-to-one relationship because multiple providers can work in one dental office, but each provider can only work in one office.

### submits

A member submits a claim. This is a one-to-many relationship, because each member can submit multiple claims as needed, but each claim can only be submitted by one member.

### services

A provider services a member. This is a many-to-many relationship, as each provider can perform procedures on multiple members, and each member can visit multiple providers.

### belongs to

A member belongs to a certain demographic. This is a many-to-one relationship, since a member can have only one active residency at a time, but a demographic will most likely contain more than one member.

### has

A member has a dental history. This is a one-to-many relationship, where each dental history must belong to a member, but a member may have more than one or no dental history at all.

### participates in

A member participates in a plan. This is a many-to-one relationship, as each member can only be part of one plan at a time, but each plan contains multiple members. This relationship also has an additional attribute, since, which shows when a member first joined the plan.

## II. Functional Requirement and Application Operation

### Overview

The application's main goal is to analyze participating members' and providers' data to maximize a dental insurance company's profits. Some possible data-backed profit-maximizing decisions may include setting membership fees based on the member's individual characteristics, cutting costs by not renewing a contract with high cost members or providers (who may be incompetent and require multiple visits for simple procedures), and targeting specific markets predicted to have high profitability by advertising to certain demographics. The calculations needed to make these decisions will be performed regularly and stored as attributes in the appropriate entities.

### Preliminary calculations

The application's algorithm first calculates the average member costs for each provider. Using this, the algorithm can find the average costs of specific groups of providers, for example all providers who live in a specific state or practice a specific specialty. Profit can be similarly calculated by first finding the individual profit gained by a provider (the average membership fee minus the average member costs) and then finding the aggregate profit after sorting by location, specialty, and other classifications.

Some potential functions include:

- `averageCostByState(state)`: finds the average member costs of all providers in a specific state
- `averageCostBySpecialty(specialty)`: finds the average member costs of all providers who practice a specific specialty
- `averageCostByPlan(plan_type)`: finds the average member costs (regardless of provider) of all members who participates in the plan

There will be similar functions for other member attributes such as age, gender, and race, and for average profits by these classifications.

### Algorithm description

The main calculation of interest for our algorithm is the expected cost of a potential member. By knowing the expected cost, the insurance company can set an appropriate insurance premium to maximize its profit.

Some of the variables to consider when calculating the expected cost may include:

- Average member costs of members with similar attributes, such as similar age or gender
- Average member costs of members living in the same state, with special focus on the average member costs of those providers who are located closest to the potential member
- Any pre-existing conditions that may influence what type (specialty) of provider the potential member will visit most often as well as the frequency of visits

## **B. E/R Diagram**

See attached PDF



## C. Relation Descriptions

### Entities

- members(member ID, *plan ID*, first name, last name, gender, age, race, address, state, income, membership tenure)
- claims(claim ID, *member ID*, *provider ID*, *plan ID*, procedure code, total cost, co-pay cost, insurance pay cost, date)
- plans(plan ID, type, member fee, number of members, plan profitability)
- provider(provider ID, first name, last name, specialty, experience, average member cost, average member profit)
- dentalOffice(location ID, address, state, total average member cost, total average member profit)
- demographics(state, population size, population density, racial shares, average household income)

### Weak entities

- dentalMedicalHistory(*member ID*, *date of service*, procedure code, cost)

### Relationships

- visits(member ID, location ID)
- works\_at(provider ID, location ID)
- submits(member ID, claim ID)
- services(provider ID, member ID)
- belongs\_to(member ID, state)
- has(member ID, date of service)
- participates\_in(member ID, plan ID, since)

We believe that there are no opportunities to combine any relations, as most of them are conceptually unique. The only similar relations are the providers and dental office entities, but to combine the two would obfuscate the costs for individual providers who work in the same office, as one incompetent dentist may drag down the averages for the other, more competent ones.