Project 1: Database Design and Data Modelling
COMP-421 Database Systems, Winter 2020

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I. Requirement Analysis

Introduction

Purpose

This application will store the data and information concerning various epidemics that interconnect hospitals, social organizations, government, and other institutions. Such an application will facilitate the expedient distribution of resources based on information on traffic conditions and the patient number of a certain region. In addition, detailed information about certain epidemic viruses and its patient in a global view are conducive to biological and medical research for that epidemy. Moreover, the history of precaution and medium can be decisive factors in the future countermeasure in the face of similar epidemy.

Scope and special requirements

The scope of this application is global and is expected to be managed and maintained by international health organizations such as WHO that are able to collect data from different countries. The application focuses on epidemy incurred by viruses, specifically ones that are highly contagious as references to future epidemic outbreaks.

Terminology

Danger Rate is the emergency grade determined according to the criteria of WHO

Resources

WHO emergencies criteria and previous cases: https://www.who.int/emergencies/crises/en/

Database description

Entities and their attributes

Virus: A virus is an agent that infects other life forms. It consists of several attributes, including the type it belongs to, the dangerous rate it corresponds to, and an additional text file including other annotations. A virus can be defined by its unique primary key called vName.

Symptom: A symptom is an illness reaction that is raised by a virus. Each symptom is associated with a unique primary key, sName, and a text file including all its descriptions.

Vaccination: Vaccination is used for curing a certain virus. Vaccination for different viruses will have different prices. It is a weak entity that can be referenced by its code and the foreign key of its institute, iName.

Region: A region is an entity where institutes are situated at. It can be distinguished by its unique name, rName. The region entity is important for analyzing problems for regional virus transmission.

Institute: A institute is a weak entity that deals with virus related problems in a region. It is-a Research Institute or is-a Hospital. Each institute has an address. An institute can be referenced by the combination of region and the foreign key of its region, iName.

Research institute: A research institute is a subcategory of the more general institute entity. It is related to the vaccination entity in order to keep a record of the organization that invented a vaccination. A research institute inherits all the attributes from the institute entity.

Hospital: A hospital is also a subcategory of institute entity. It will also inherit the attributes from the institute entity. It is related to the patient entity, as it keeps the information about patients that have been to the hospital before.

Patient: A patient is a person who has or had been infected by the virus. The database keeps track of the unique foreign key, the combination of nationality and national ID. A patient will also have a file that listed out the personal information.

Medium: A medium describes the way that a person could catch a virus. Each medium has its own contagious level and a unique foreign key, mName.

Precaution: A precaution is a method that is applied to fight against a virus. Each precaution has a unique foreign key pName.

Relationships

Infect: A virus can infect a person, who would later become a patient. This is a many-to-many relationship. It is because a virus can infect multiple people, and a person could be infected by several viruses as well. The patient entity has a participation-constraint, because information of a patient is only kept in the dataset only if one became a victim of the virus.

Against: A vaccination fight against a virus. This is a one-to-many relationship. This is because a virus can be fought against by different vaccinations, but vaccination can only be used to prevent a virus from spreading.

Invent: A vaccination is invented by a research institute. This is a one-to-many relationship because a research institute can invent many vaccinations, but vaccination is assumed to be invented by a research institute only.

Accommodate: A hospital serves as patients' accommodation for patients. This is a many-to-many relationship, since a hospital can contain a wide amount of patients, and patients can stay in different hospitals as well.

Incur: A virus can incur a symptom. This is a many-to-many relationship because a virus can lead to different symptoms, and the same symptom can result from the infection of different viruses.

Exhibit: A symptom is exhibited by a patient. This is a many-to-many relationship because a patient can have multiple symptoms, and a symptom can be shared between different patients.

Spread: A virus can be spread around using medium. This is a both-side-participate-constraint relationship since a virus must be spread at least one medium, and a recorded symptom must be linked with a virus.

Prevent: Precautions can be applied and prevent a virus from spreading. This is a many-to-many relationship. This is because a precaution method can be applied to different viruses, and a virus can be prevented with multiple precaution methods.

Apply: Each region can apply different precautions. This is a many-to-many relationship since a region can apply many precautions and the same precaution can be applied across different regions.

Closed Border: A region can close the border to another region. This is a spin-off relationship. A region can be a closed border to another region.

Locate: An institute is located in a region. This is a one-to-many relationship because a region can have multiple institutes, but an institute must be located in a single region.

Application description

Overview

In aims to improve the efficiency of counteraction and preparation for the future, an optimization algorithm can be used for calculating evaluative factors to optimize efficiency with the base of current attributes, while saving system resources and prevent redundancy.

Preliminary calculations

The algorithm calculated the infected number and death number of a virus which were retrieved from the infection relationship. These attributes could be a primitive indicative index for the severity of epidemy and precaution effectiveness. In addition, the first infection time is also retrieved from the infection time as the genesis of this epidemy, which can be used to observe patterns for epidemic outbreak in the long run.

Function examples

Infected number(virus): retrieved as the sum of total infect relationship recorded.
First infection time: retrieved from the earliest recorded time in infect
Total patient number: retrieved from accommodation relation

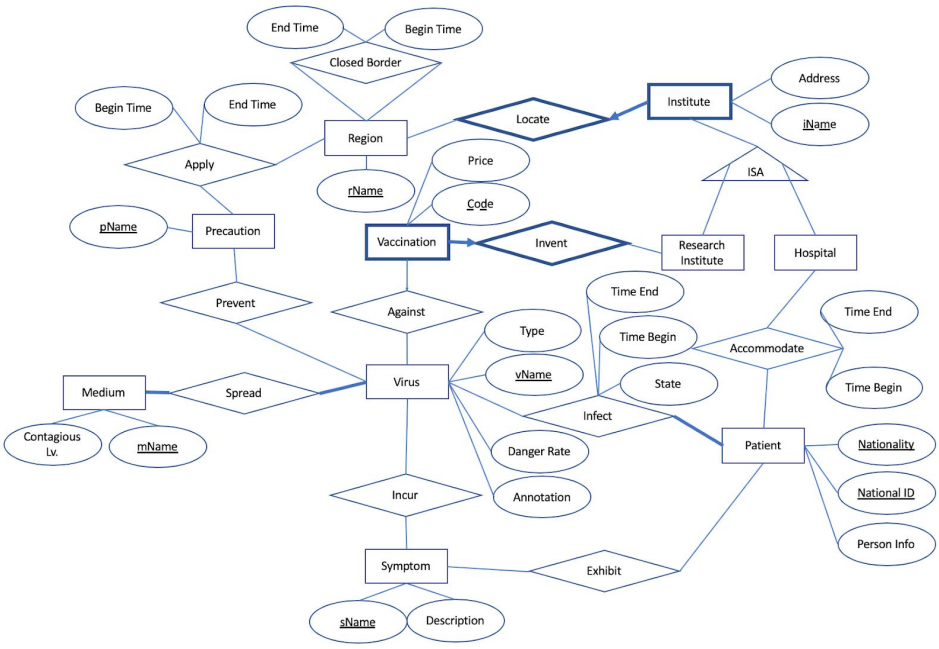
Algorithm description

The algorithm relies on the preliminary result and information collected from the database to generate evaluative and indicative indexes for the counteraction of an epidemic outbreak. In specific, relating the effectiveness of certain precautionary measures or the deficiency in different aspects.

Variables to be determined

- Death rate, based on infected number and death number
- Outbreak frequency, based on the first infection time
- Expected hospital number: base on total patient number across time

II. ER Model



III. Relations

1. Virus（vName, Type, Danger Degree, Annotation）
2. Symptom (sName, Description (Text))
3. Region (rName,, population)
4. Institute (rName, iName, Address)
   rName ref Region
5. Hospital (rName, iName, Address)
   rName ref Region, Iname, Address ref Institute
6. Research Institute (rName, iName, Address)
   rName ref Region, iname, Address ref Institute
7. Medium (Source) (mName, Contagious Ability) Lv (0-5))
8. Precaution (pName)
9. Patient (Nationality, National ID, Person Info)
10. Vaccination (iName, Code, Price)
    iName ref Institute
11. Incur (vName, sName)
    vName ref Virus, sName ref Symptom
12. Against (Code, iName)
    Code ref Vaccination, iName ref Research Institute
13. Infect (vName, Nationality, National ID, BeginTime, EndTime, State)
    vName ref Virus, Nationality, Nation ID ref Patient
    Virus and Patient has participation constraint in the relation Infect
14. Spread (vName, mName)
    vName ref Virus, mName ref Medium
    Virus and Medium has participation constraint in the relation Spread
15. Apply (RName, PName, Time, Virus Name)
    RName, ref Region, PName ref precaution
16. Closed Border (R1rName, R2rName, Begin Time, End Time)
    R1rname, ref region, R2rName, ref region
17. Accommodate (Nationality, National ID, BeginTime, Endtime)
    Nationality, National ID ref Patient
18. Exhibit (sName, Nationality, national ID)
    sname ref Symptom, Nationality, National ID ref Patient