Database Theory and Application Development

Assignment 1 - Relational Database Modelling

This assignment is to perform the logic design of an information system. It involves the construction of an ER diagram, mapping to the relational schema, and the normalization of the resulting relational schema. The necessary information for schema design is given in the Universe of Discourse (UoD).

This assignment can be completed as an individual. If it is found that two people have too many repeats, then the results of both sides will be whichever is the lowest.

1 A Home-Healthcare Information System

1.1 Background

Aged care is important to a society. Many elderly people live alone at home. The existence of broadband communication networks in China enables home-healthcare information systems to play an important role in people's lives.

You are required to create a central database that is able to record remote health monitoring data and to provide home healthcare information for people. Nowadays, with the in-house Bluetooth/Wireless technology and broadband Internet connections, healthcare experts sitting in a remote/central office are able to provide consultation services and expert professional advices to people through tele-medicine technologies and software systems.

This information system should be designed to provide services that allow healthcare stakeholders to interact with each other and share healthcare information. The system will record personal information as well as the healthcare-related diagnostic data collected at home.

In addition to diagnostic data, such as heartbeats and blood pressure that can be submitted online, healthcare-related physiological data can also be collected via sensors without supervision in people's homes. *Appendix A* shows a list of diagnoses that can be performed at home by using sensors without personal training or can be performed with remote supervision.

We assume that people who will subscribe to this remote home-healthcare system can handle all tests required in health monitoring, e.g., Breast Cancer self-tests. The home-collected data, including samples, can be physically transported to the central office either by a courier or by Internet-connected electronic sensors installed in the home.

1.2 The Universe of Discourse (UoD)

We identify two types of users in this system: home users and online experts. Home users can register with the system in order to receive the consultation services of the system and become members of this Home-Healthcare Information System. User information is about contact details, personal details, disease history, current medication/therapy, and allergies. A home user may have a designated online expert responsible for providing them with healthcare

consultations. Home users can use this system to register their personal details and enter the status of their personal health conditions, including complaints, symptoms, home-collectable diagnostic test results, or healthcare questions.

Online experts are the professionals who will log into the system and browse home users' information, provide their opinions about the symptoms reported by home users, answer questions asked by home users, or instruct home users to take home-collectable (self) diagnostic tests. Online experts should have their contact details and professional credentials recorded. Online experts can play different roles including but not limited to clinicians, specialists, GP (General Practitioners), therapists, or medical/healthcare consultants. Online experts give opinions on what diseases that the home users might have contracted, what treatments should be recommended to the home users, and how those healthcare activities can be performed at home.

An online expert may be responsible for consultations with many home users. When online experts are browsing the home users' health statuses, they may give instructions to home users on how to conduct home-collectable diagnostic tests. Upon seeing the test results, online experts may either enter their diagnostic opinions (diagnoses) into the system, recommend treatments, or initiate further investigations on possible healthcare solutions for home users.

Signs and symptoms are the phenomena reported by home users or observed by online experts. Signs and symptoms should be recorded with timestamps, severity, and worded descriptions.

Diagnoses are the opinions given by clinicians/specialists based on their professional judgement when they see the evidences. When home users report their health status, they may describe signs or symptoms that could be associated to a certain disease. A diagnosis should be recorded as a written description and include the time that the diagnosis was given. The disease that is contracted by a home user may also be identified in the diagnosis.

Diseases should be recorded with the type of disease, name, and their text descriptions.

Home-collectable diagnostic tests should be recorded with data described in *Appendix A*. When a home-collectable diagnostic test is performed by a home user, its results (with time, description, positive/negative etc.) should be recorded.

Treatments are the recommendations that clinicians give in their consultations with home users. Treatments can be recorded as name, type, and descriptions in words.

Healthcare questions are the written messages asked by home users based on their health conditions. A healthcare question should be recorded with timestamp, type of question (Private or Open), title of the question, and the text of the question etc. One home user may ask many questions. An open question asked by a home user can be seen by all online experts. A private question asked by a home user can only be seen and answered by their designated online expert.

Healthcare questions may be answered by online experts based on their professional knowledge and experiences. The healthcare questions and answers should be recorded with timestamps, together with the type of answers (Private or Open), and the text of the answer. One online expert may answer many questions. One question may have many answers.

All users enter the system through a registration process, wherein, they are given a unique login. After joining, users can access the system by entering the required information.

Different users may have different consultation processes. A home user uses this system to enter their health status (e.g., signs and symptoms), home-collectable diagnostic test results (if any), or ask questions to online experts. Online experts may use this system to enter diagnoses,

recommendations of treatments, or answer questions asked by home users. Online experts should be able to browse the list of home users and their questions.

2 Schema Design

Quality and accuracy of schema design is important in this assignment. The following describes what is expected in this assignment.

2.1 ER Diagram

Create an ER diagram to represent the conceptual schema described by the Universe of Discourse. For cardinality and participation dependency, you may use either standard notation, or the alternate (min, max) notation, but not both.

State any assumptions you make regarding your design. Assumptions are to be submitted together with the ER diagram as a part of your design document. Please note that you cannot make assumptions to simplify or compromise the completeness of the Universe of Discourse. If there are any points that need clarification, in the specification of the given Universe of Discourse, you must first attempt to clarify them with your tutor and/or lecturer. You should refrain from making your own assumptions.

2.2 Mapping

Map the ER diagram created in 2.1 to a relational database schema. Document the mapping steps. The final schema should be given in the notation as given in your lecture notes, e.g. *R1 (key_attr, attr1, attr2, …)*. In order to identify referential integrity constraints, be sure to either use the same names of the referenced/referencing attributes, or write this separately e.g. R1(attr1) references *R2(some_key_attr)*. You can also use a schema diagram that identifies referential integrity constraints through arrows.

2.3 Normalization

All relations resulting from ER-to-Relational mapping should be normalized up to the third normal form (3NF). Document your reasons for normalization, clearly stating the normal form of the original relation, and of the resulting relation(s).

Tip: It is highly likely that the relations in the schema you come up with at the end of the ER-Relational mapping (see section 2.2) are already in 3NF. However, you still need to write the (non-trivial) FDs between the attributes of each of the relations you designed, and demonstrate that the relation is actually in 3NF by running the 3NF test on it.

For each relation given in the final schema from 2.2 show the following

1. Identify non-obvious functional dependencies,
2. Determine if there are any partial/transitive dependencies,
3. If necessary, decompose the relation to make 3NF relations,
4. Clearly state the normal form of the original relation, and of the resulting relation(s).

Here is an example of what you may document in this part:

R1 (A, B, C, D)
FD: AÆBCD

No partial or transitive dependencies found. R1 is in 3NF.

2.4 Tutorial Support

You may seek tutor support to clarify your understanding of the Universe of Discourse. You may also discuss the concepts behind ER modelling and mapping, in general, with your tutor.

3 Submission

A template for the submission of this assignment is given on the DY $S.S You are to download this (Assignment1-SubmissionTemplate.doc) file and prepare your assignment using the template document. 7KH WHPSODWH FRQWDLQV PRUH DQG PRU DERXW WKLV SURMHFW

When completed, you are VXSSRVHG to submit your ER diagram and documented steps of the ER-to-Relational mapping process and normalization as a text file (in MS WORD or PDF format).

Your submission should be a single file. If you have more than one file to submit, you need to compress them into a single .ZIP file for the submission. The single file name for the submission VKRXOG EH <2850,' $1' 1$0(ZIP

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4 Requirement

This assignment targets the following assessment criteria of this course:

Extract (simplified) specifications to create basic conceptual data models
Map basic conceptual data models to relational database schema
Reason with the logical foundation of the relational data model
Understand the fundamental principles of correct relational database design
Construct simple computer-based information systems given a complete specification

APPENDIX A: Home Collectable-Healthcare Tests [i]

Condition	Test Process	Tool Name	Method
Allergy	quantitative screening test	MyAllergyTest kit	Skin needle prick with visible result
Glucose, Protein, pH (Uri-3) and seven other diagnostic chemical panels (Uri-10) in human urine	urinalysis reagent strips	Uri-Strip K	Dip strip in urine with visible result
Colorectal cancer	occult blood screen	EZ DETECT™	Test pad is placed in the toilet bowl along with a bowel movement with visible result
Breast cancer	Breast Self-Examination Pad and Kit	AWARE™	Reduces friction between the fingers and the breast tissue thereby facilitating and enhancing the early detection of suspicious abnormalities or lumps during routine breast self-examination
Prostate Cancer	PSA Screening Test	LANDMARK	Skin needle prick with visible result
Anaemia	Anemia Haemoglobin Meter	BioSafe®	Skin needle prick with visible result
Diabetes	Glucose Diabetes test	CHEMCARD™	Skin needle prick with visible result
High cholesterol	Home Cholesterol Test	VENTURE™	Skin needle prick with visible result
HIV	HIV-1 Test	Home Access®	Skin needle prick with visible result
Hepatitis C	Hepatitis C Test	Home Access®	Skin needle prick with visible result
Influenza	Influenza A/B Test	QuickVue	Nasal specimen swab sent to pathologist
Thyroid problems	Thyroid Stimulating Hormone test	Landmark Diagnostics	Skin needle prick with visible result
Kidney disease	Albumin in urine	FlexSite At Home Kidney Screen	Mail urine sample to pathologist
Skin cancer	Skin monitoring system	Visiderm	Each transparent Visiderm sheet becomes a dated record of a mole. Subsequent recordings create a method of comparing the present mole to prior recordings and documenting and noticing even subtle changes.
Osteoporosis	key bone marker, deoxypyridinium (D-Pyd)	Osteo Check	Mail urine sample to pathologist

Hormone balance	estradiol, progesterone, and testerone levels	Female Check	Mail saliva sample to pathologist
Minerals and toxins	MINERALS: Calcium, Chromium, Cobalt, Copper, Iodine, Magnesium, Manganese, Selenium, Strontium, Sulfur, Zinc TOXIC ELEMENTS: Aluminum, Antimony, Arsenic, Bismuth, Cadmium, Lead, Mercury, Nickel, Tin	Mineral Check by Body Balance	Mail hair sample to pathologist
Cancer causing radon	Radon	Radon Home Test Kit	Mail home air samples to pathologist
Heart disease	C-Reactive Protein	CRP	Skin needle prick sent to pathologist
Heart disease	Lipid test	Lipids	Skin needle prick sent to pathologist
Acute ear infection	Middle Ear Infection Monitor	EarCheck EC-2	Ear monitor with visible result
Genetic Health Risks	DNA	Premium Home DNA Test	Skin needle prick sent to pathologist
Liver cancer	check if elements in the blood match genetic information about the diseases	Digital Bio Disc	Skin needle prick with visible result
Diabetes	check if elements in the blood match genetic information about the diseases	Digital Bio Disc	Skin needle prick with visible result
Cancer	breast, ovarian, lung, uterine, prostate, testicle, colorectal, pancreas, liver, stomach, thyroid	Cancersafe®test	Blood sample sent to pathologist
Ovarian cancer	ovarian cancer test	OvPlex™	Blood sample sent to pathologist
Bladder cancer	Urine test	BTA stat test	Urine on screening test pad with visible result

[i] This list is provided by Dr Lisa New