



Coláiste na Tríonóide, Baile Átha Cliath
Trinity College Dublin

Ollscoil Átha Cliath | The University of Dublin

Faculty of Engineering, Mathematics and Science

School of Computer Science & Statistics

Integrated Computer Science Programme
Business and Computing Programme

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Information Management II

12th Jan 2020 (12 noon to 3pm)

Exam

Prof Vincent Wade, Prof Yvette Graham

Real-time Online exam

Instructions to Candidates:

Attempt **three** questions in total. **Question 1 is mandatory.** Answer **any two** questions from **Question 2, Question 3 and Question 4**

1. The ReallyGoodRestaurant has decided to open a small shop beside the restaurant to sell high quality artisan cooking ingredients. The restaurant uses several suppliers to provide good ingredients. Each supplier supplies an ingredient in only one unit size e.g. supplier A supplies sea salt in bags of 500 grams and supplier B supplies sea salt in 250 gram bags. Each supplier charges a specific price for an ingredient in that unit size. However different suppliers can provide the same ingredient in different unit sizes.

Also to encourage the sale of these ingredients, the restaurant provides a text description of the recipes used in the restaurant and indicates which ingredients from each recipe can be bought from the shop. Each recipe has been designed by one or more chefs in the restaurant.

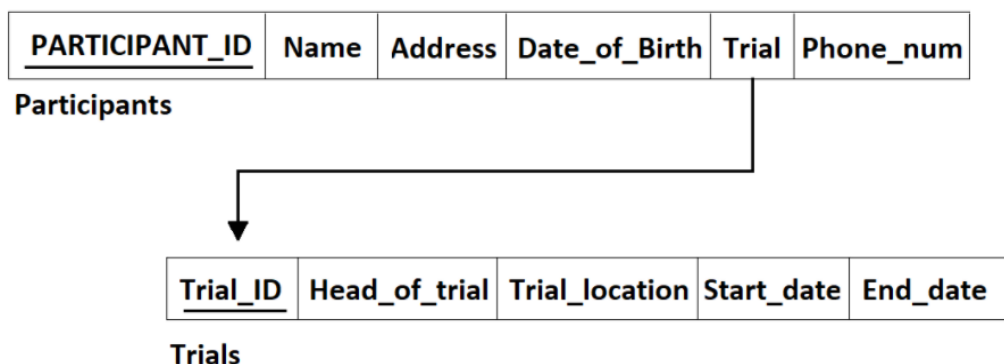
The ReallyGoodRestaurant needs to maintain a database capable of storing information about ingredients, the suppliers of those ingredients, the unit size that each supplier supplies a particular ingredient, a text description of each recipe, the name(s) of the chef(s) who designed each recipe, an indication of which ingredients are used in which recipes, the cost (to the restaurant) of ingredients in a particular unit sizes from suppliers, and the price for which the shop sells each ingredient (in a particular unit size).

- (i) Develop an Entity Relational (ER) Model for the above database, stating any assumptions you make. [10 Marks]
- (ii) Using the appropriate mapping techniques, map the ER Model to a Relational Model and show the functional dependency between attributes within each table. In your answer, identify the Primary and Foreign keys for each relation. [5 Marks]
- (iii) Give the SQL command(s) for the following queries:
 - (a). Retrieve a list of ingredients sold by the shop for the recipe 'Baked Lasagne' [2 Marks]
 - (b). One of the existing suppliers (named 'Honest Henry') has a new ingredient (roasted chestnuts in units size of 400 grams) to be sold in the shop. The shop buys this ingredient €3 per 400 gram bag and the shop sells it for €8 per (400 gram bag). Give the SQL commands needed to enter this new ingredient. [2 Marks]
 - (c). Create a view of all the ingredients of supplier 'Honest Henry' with the unit size he supplies and the price he charges for that unit size. [3 Marks]

- (d). Suppose the restaurant wishes to increase the prices for all ingredients it sells in the shop by 8%. Give the SQL command(s) required to make this happen.

[3 Marks]

- Q. 2 A database manager is designing a relational database to store information about research laboratory experiments involving Covid-19 vaccine trials. Below is part of the database design for information stored about vaccine trials:



When setting up human trials for experiments, some human participants will be added to a trial but can later become ineligible and need to be removed from the trial. Participants only take part in a single trial but this is not explicitly enforced within the schema. So, if someone is a participant in a trial for vaccine A, that is the only trial they will participate in.

- (i) If a human participant is deleted from a trial, then all of his/her information should be deleted. Say what kind of constraint this applies to, security or integrity.

[3 Marks]

- (ii) Below is a list of potential operations that could be carried out on the database. For each of the below examples, say *whether or not* the operation violates integrity constraints and if so, the *kind of integrity constraint* that is violated and *why it is violated*:

- (a) A new trial is started and information needs to be stored about that trial. Because we don't yet know the ID number of the trial at this point, an *insert* is carried out on the Trials table to insert the information about the new Trial, leaving Trial_ID null for now.

[3 Marks]

- (b) Another trial begins, this time they do not yet have an estimated end date for the trial, so a tuple is inserted into the Trials table with a single attribute set to null, the End_date.

[3 Marks]

- (c) A trial is deleted from the Trials table with nothing removed from any other tables.

[3 Marks]

(iii) Provide the SQL command to add a constraint that enforces the start date of all human trials to be after 28th February 2019.

[5 Marks]

(iv) Provide the SQL to avoid a referential integrity violation that would result from a Trial being deleted from the Trials table.

[8 Marks]

Q. 3

Stocks

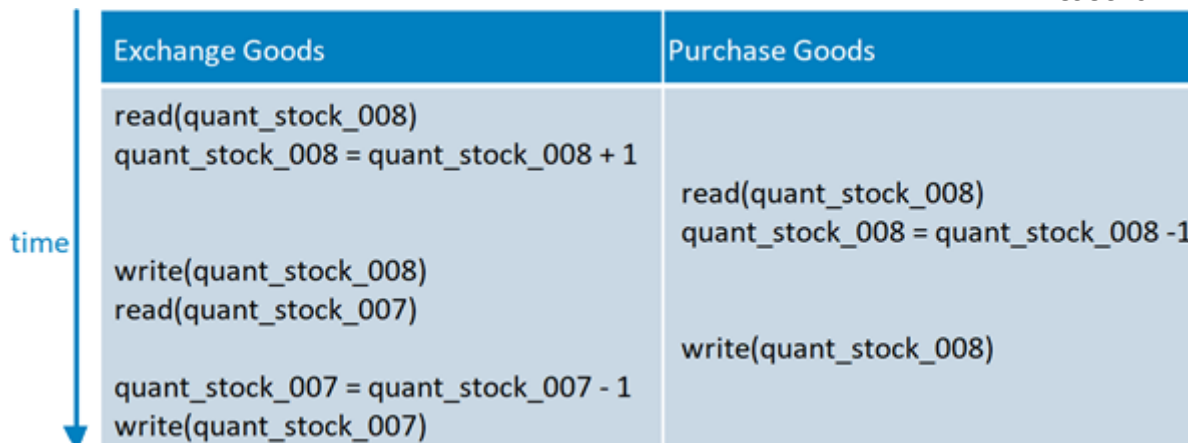
SKU	style	colour	size	product_name	customer_type	quant_stock
006	Skinny	Blue	Medium	Jeans	Women	110
007	Bootcut	Black	Small	Jeans	Men	150
008	bootcut	black	Medium	Jeans	Men	143

The above database is used to record the stock levels of products in an online clothes shop. Each product for sale can be uniquely identified by its stock keeping unit (SKU), a code that is also present in the bar code used when paying for items. Data within the table should accurately reflect the actual number of items stored in boxes in the warehouse to avoid items being sold to a customer when they are in fact already sold out.

When a product is returned, via the local postal service, an employee is required to log this item as returned and purchase and send out a replacement item. This often happens when someone buys an item that is the incorrect size, for example.

In addition, the ordinary purchase of items also regularly takes place and both exchange of goods transactions and purchase transactions can potentially occur at the same time. A good database manager will ensure that if two such transactions occur at the same time, the stock levels recorded in the database after both transactions are complete, will still be correct.

Below is one possible way the transactions could be executed concurrently within such a system:



(i) Provide the schedule of operations depicted in the diagram, where Exchange Goods is Transaction₁ and Purchase Goods is Transaction₂, and a list of any potential conflicts.

[5 Marks]

(ii) Provide an alternative schedule that fixes any issues with the above schedule and describe any advantages or disadvantages of the approach you chose.

[8 Marks]

(iii) Add locking to the schedule and explain what will occur when the wait-die protocol is applied, making use of a wait-for graph in your explanation.

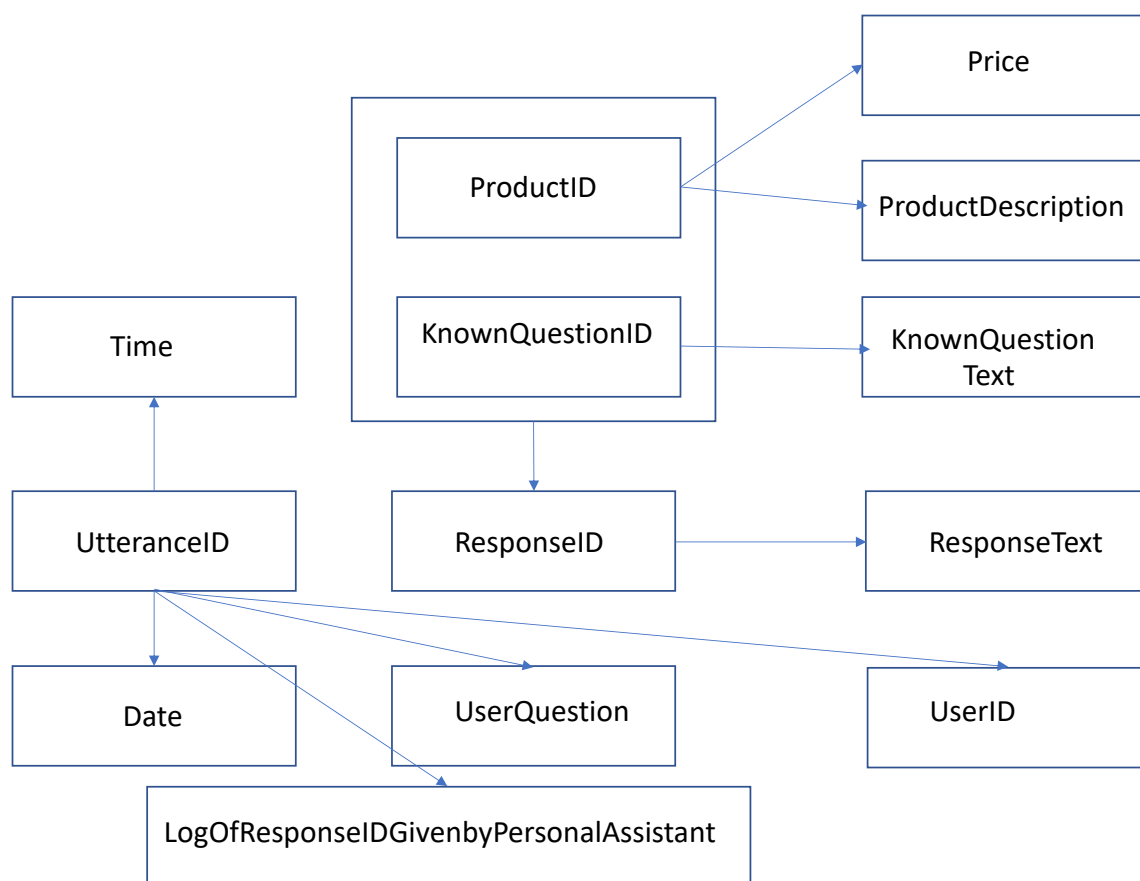
[12 Marks]

Q. 4 Personal Assistants are programmes which respond to user utterances (spoken or typed commands). For example, they can be used to provide helpful answers to a user's question about products on a website. A simple Personal Assistant works by (approximately) matching a user's query about a product to a previously known question about that product and then choose the appropriate answer or response for that known question. If the simple Personal Assistant cannot match the user's query to a known question & product, it just returns a default error message "Sorry I don't understand, can you rephrase your question?").

Suppose a Simple-PersonalAssistant contains a database to store 'known questions' about products available on a retail website and a set of appropriate responses for such known questions. The Simple-PersonalAssistant works by taking each user's utterance (question) and matching it to the most similar known question stored in the database. You may assume the Simple-PersonalAssistant uses an internal algorithm to match the user question about a particular product to the most similar known question. It then

looks up which response is appropriate for that known product related question and retrieves that response.

Thus, the Simple-PersonalAssistant database stores a list of known questions about the website products, the product(s) to which each known question relates and the IDs of the response appropriate for that known question. For each product the database stores the product ID, its description and its current retail price. The database also stores each predefined Simple-PersonalAssistant's response (as text) and a unique ResponseID to identify each response. For logging purposes, the database also stores the original text of a user's question (utterance), the user ID of the person who asked the question, the time & date of which the question was asked and a log of the ResponseID which the Simple-PersonalAssistant gave for the question (utterance). As it cannot be assumed that every user question is unique, the Simple-PersonalAssistant also generates a unique utterance ID for each question asked by a user.



- (i) Identify the primary keys, foreign keys and other attributes of EACH of the tables in the above Functional Dependency diagram.

[9 Marks]

- (ii) Using examples from the tables in (i) above, explain 1st, 2nd and 3rd Normal Forms.

[3 Marks]

(iii) Write SQL commands to perform the following:

(a). List all of the KnownQuestions and their ResponseTexts for the ProductID 10090.

[5 Marks]

(b). Give the SQL commands to store a new Response where the ResponseID is 555 and the ResponseText is "This product can only be sold to a person over 18 years of age". Suppose this response is the appropriate response for KnownQuestionIDs 77 & 78, about the Product with ProductID 10010. Give the SQL commands needed to relate the response to these KnownQuestionIDs and ProductID. You may assume that the Product information for ProductID 10010, and related KnownQuestionTexts for KnownQuestionIDs 77 & 78 already exists in the database but had not yet been assigned a ResponseID

[5 Marks]

(c). Give the SQL command to define the table which contains User Question, Utterance ID, the User Id, the Time and Date of the question and the log of ResponseID given by personalAssistant for the question. In your answer indicate how you would ensure that the UtteranceID would be automatically created and always unique.

[3 Marks]