Practical 4

ER to relational mapping, normalization and creating SQL statements to implement relations with foreign keys

Learning objectives

1. Convert an ER diagram to suitable relational schema, mapping different forms of entities, attributes, and relationships
2. Check whether a relation is in 1NF, 2NF, 3NF or BCNF, looking at it's schema.
3. Decompose a relational schema to make it adhering to different normal forms.
4. Implement a relational schema with primary and foreign key constraints in MySQL
5. Use FDs to identify keys of a given relation.

Setting-up

- Tasks 2, Task 7 and some additional tasks use ER diagrams you have created in the previous practical sheet.
- Save your work of this practical is DBS/Prac04 directory. If Prac04 directory is not already there, create a one.
- Write down your answers in a text file named '**Prac04Answers**', unless another specific file (e.g., .sql file) is supposed to create for any task. Add your name, student ID at the top of the text document.
- For tasks 3 -5 and some sections of task 6, you can simply use a pen and a paper to write down/ draw FDs and find normalization stages etc. Take photos and add them to your **Prac04Answers** file.

1. ER to relational mapping – Student information system scenario

a) Convert the ER diagram given for simple student's information system in Lecture 04 slide 20 to a relational schema, following the steps given in the Lecture 04.

b) Create a description of your tables to create. Use the format given in the lecture 04 slide 22.

2. ER to relational mapping – Airport scenario

a) Convert the ER diagram you have created last week for a 'simple airport scenario' (Practical 03, task 1) to a relational schema, following the steps given in the lecture 04.

b) Create a description of your tables to create. Use the format given in slide 22 of the Lecture 4.

3. Normal Forms

Consider the following FDs for the relation R(A,B,C,D,E,F,G).

AB→ABCDEFG

A→D

B→EF

G→A

a) Draw a diagram to indicate above FDs on the relation R.

b) Find what normal foam the relation is adhering to (start from 1NF). Refer lecture slides for examples of this process.

c) Convert the relation to BCNF.

4. Normal Forms of the designed relations

a) Check whether the relations you have created in task 1 above are in 1NF.

b) Use suitable checks based on FDs and test whether the relations you have created are in 2NF or 3NF. If not, convert them to 3NF.

Note -1

- First, identify all the FDs of a relation you have identified in your schema. Write them down/ use a diagram (as shown in the lecture 04 slides, normalization section) to indicate them. Start with one relation.
- Once you have identified all the FDs of the selected relation, go through them to make sure that each makes sense.
- Check that you chose the correct keys – if you removed one or more FDs, still key properties remain, this attribute is a super key but not a key. Also, if one of the relations from the ER diagram has multiple foreign keys as well as other FDs, it may be possible to find a smaller key.
- Then, looking at the 1NF condition, check the relation is of 1NF. If so, decompose the relation. If the relation is of 1NF, check if the relation is of 2NF. If so, decompose the relation. Do this process for 3NF also. If any stage resulted in decomposing, use the decomposed relations in the next stage.
- Do the same for all the relations of the schema.

c) If any decomposition is done, revise your table descriptions created in the task 1 (b) above.

5. Implementing the relations in MySQL

For this question, use a text editor (e.g. Vim) to type the MySQL statements and save the file as 'sims.sql'

a) Using the example given in Lecture 4, slide 24 as a guideline, write down the SQL statements to convert the relational schema you have created in the task 1 above (for the student's information management scenario). Implement primary keys, foreign keys, and any other constraints you can find as well.

   Add suitable comments to your .sql file. Indicate any assumptions you made also as comments.

b) Using 'dsworks' as the current database, run the 'sims.sql' file to create relations to manage student management scenario.

6. Functional Dependencies and keys

Consider a relation with schema $R(A,B,C,D)$ and FD's $AB \rightarrow C$, $C \rightarrow D$, and $D \rightarrow A$.

a) Find all nontrivial FD's that follow from the given FD's. Consider only FD's with single attributes on the right side.

b) What are the keys of R? (Hint: find the closure of different attribute sets)

c) What are the super-keys of R that are not keys?

7. ER to relational mapping, checking normal forms and implementing tables – Airport scenario

a) Check whether the relations you have created in task 2 above are in 1NF.

b) Use suitable checks based on FDs and test whether the relations you have created are in 1NF, 2NF or 3NF. If not, convert them to 3NF.

c) Convert the normalized relations to the SQL statements to implement the relations as tables in a file name 'airport.sql'. Implement primary keys, foreign keys, and any other constraints you can find as well.

   Add suitable comments to your 'airport.sql' file. Indicate any assumptions you made also as comments.

d) Using 'dsworks' as the current database, run the 'airport.sql' file to create relations to manage student management scenario.

Additional Tasks:

1. Suppose we have a database for an investment firm, consisting of the following attributes: B (broker), O (office location of a broker), I (investor), S (stock), Q (quantity of a stock owned by an investor), P (current price of stock), and D (last dividend paid by a stock). An investor has only one broker, and a broker has only one office location. For each stock, there is only one value of dividend and only one price in the database. For each investor who owns a stock, the total quantity of the stock is recorded.

   a) Determine the functional dependencies that apply to this database.

   b) Find the keys of the relation R (B,O,I,S,Q,P,D).

2. Consider a relation R (A, B, C, D), with the following set of functional dependencies (FD's) over. R: AB→C, BC → D, CD → A, AD → B.

   a) Find all the nontrivial FD's (with single attributes on the right hand sides) that follow from the given FD's.

   b) What are the keys of this relation? Give the reasons for your answer.

8. ER to relational mapping , checking normal forms and implementing tables complete workflow: residents of a city scenario

   a) Convert the ER diagram you have created last week for a 'Residents of a city' scenario (Practical 04, task 2) to a relational schema, following the steps given in the Lecture 04.

   b) Create a description of your tables to create. Use the format given in slide of the Lecture 4.

   c) Check whether the relations you have created are in 1NF.

   d) Use suitable checks based on FDs and test whether the relations you have created are in 1NF, 2NF or 3NF. If not, convert them to 3NF.

   e) Convert the normalized relations to the SQL statements to implement the relations as tables in a file names 'residents.sql'. Implement primary keys, foreign keys, and any other constraints you can find as well.

      Add suitable comments to your residents.sql file. Indicate any assumptions you made also as comments.

   f) Using 'dsworks' as the current database, run the residents.sql' file to create relations to manage student management scenario.

9. Submitting your work

Your prac04 directory should have 'Prac04Answers' document and several files. Zip your Prac04 directory and upload it to Blackboard under Assessments/In class practical Submissions/Practical 4 link.

Note 2: Zip your directory

- Go to your DBS directory and type:

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> zip -r Prac04_<your student ID> Prac04
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Check whether you have achieved learning outcomes:

I am confident that I can,

Convert an ER model to relational schema, mapping different forms of entities, attributes, and relationships such as: • Composite, derived, or multi-valued attributes. • cardinality (one-one, one-many, many-many), • participation (fully or partial participation), • weak entities, • is-A relationships.	✓
Indicate constraints such as primary and foreign keys when mapping an ER model to relational schema.	
Use FDs and find keys of a relational schema.	
Identify whether a schema is in 1NF and if not convert it to 1NF.	
Identify whether a schema is in 2NF and if not convert it to 2NF.	
Identify whether a schema is in 3NF and if not convert it to 3NF.	
Identify whether a schema is in BCNF and if not convert it to BCNF.	
Implement a given relational schema using CREATE TABLE statements with clauses to add primary key and foreign key constraints in MySQL.	

Please refer lecture slides, reading materials, and online resources and attempt again, if all the learning outcomes were not achieved. Ask your tutor and get help if you need any clarification.

It's always a good practise to try to finish the practical of a particular week before attempting the next practical worksheet, as your work will be building upon the previous week's tasks.