University of California, Los Angeles
Department of Computer Science

Computer Science 143 **Prof. Ryan Rosario**

Homework 4

Due Friday, June 1, 2018 at 11:59pm on CCLE

Please remember the following:

1. Homework is mostly graded on completion. We may grade a few parts, but it will never be the majority of the grade on the assignment. So try your best, and focus on solving the problems. Consider homework (and studying the solutions) as practice for the final exam.
2. Homework must be submitted digitally, on CCLE. We will not do any paper grading. You can use a text file, but if you use Word, a PDF is preferred rather than a DOC file.
3. If there are any exercises that are difficult to do digitally (such as diagrams or math), consider scanning your drawing or math, or using a graphics program (even a readable MS Paint is fine) or Equation Editor.
4. **For the sanity of the grader** we will ask you to run the queries and submit the result. You may lose points if you only provide a query.
5. Solutions will be posted.

Part 1: There's Nothing Wrong with Being Abnormal Unless you are a Relation

1. Suppose that we decompose the schema $R(A, B, C, D, E, F)$ into $R_1 = (A, B, C, F)$ and $R_2 = (A, D, E)$. Given the following functional dependencies hold, is the decomposition lossless? Explain your answer.

$$F = \{A \to BC, CD \to E, B \to D, E \to A\}$$

2. List non-trivial functional dependencies satisfied by the following relation. You do not need to find *all* dependencies. In other words, please F, but there is no need to find F^+. It is enough to identify a set F of functional dependencies that imply all functional dependencies satisfied by this relation.

A	B	C
a_1	b_1	c_2
a_1	b_1	c_2
a_2	b_1	c_1
a_2	b_1	c_3

3. Assume the following set of functional dependencies hold for the relation $R(A, B, C, D, E)$:

$$F = \{A \to BC, CD \to E, B \to D, E \to A\}$$

   (a) Is E a key for R? Explain your answer.

   (b) Is BC a key for R? Explain your answer.

4. Assume the following set of functional dependencies hold for the relation $R(A, B, C, D, E, F) : F = \{A \to BC, C \to E, B \to D\}$

   Is R in Boyce-Codd Normal Form (BCNF)? Explain your answer. If it is not, normalize it into a set of relations in BCNF.

5. Suppose we have a relation $R(A, B, C, D)$ with a multivalued dependency (MVD) $A \twoheadrightarrow BC$. If we know that the tuples $(a, b_1, c_1, d_1), (a, b_2, c_2, d_2), (a, b_3, c_3, d_3)$ are in the current instance of R, what other tuples do we know must also be in R?

6. For relation $R(A, B, C, D, E, F)$, suppose a functional dependency $AB \to E$ and two multivalued dependencies $AB \twoheadrightarrow C$ and $A \twoheadrightarrow B$ hold. Is R in 4NF? Explain your answer. If not, normalize it into 4NF.

Part 2: Entity-Relationship Status – It's Complicated

1. You are to design a database that maintains information for producing a weekly television guide for a given region (such as the Greater Los Angeles region). The data should include information about television shows, television networks, cities, channels, show times, etc. For starters, you may make the following assumptions:

   - A given channel in a given city is associated with one network.
   - A given show is either owned by a network (and shown on a channel associated with that network) or is a local show and may be shown on any channel.
   - Not all shows are shown in all cities, and the days and times for a given show may differ from city to city.
   - You may ignore cable channels, which generally are not city-dependent.

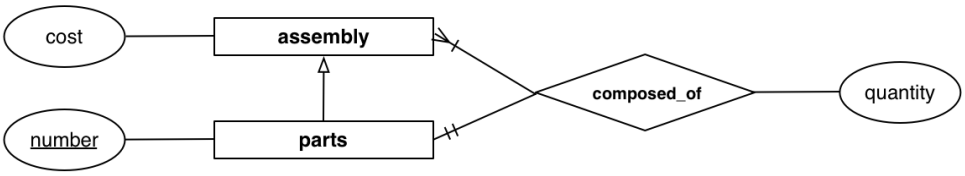
   Please feel free to make additional assumptions about the real world in your design, as long as the assumptions are reasonably realistic and are stated clearly as part of your solution.

   Specify an entity-relationship diagram for your database. Dont forget to underline key attributes and include arrowheads and double lines.

   Note that this question is fairly open-ended and there is no single right answer, but some designs are better than others.

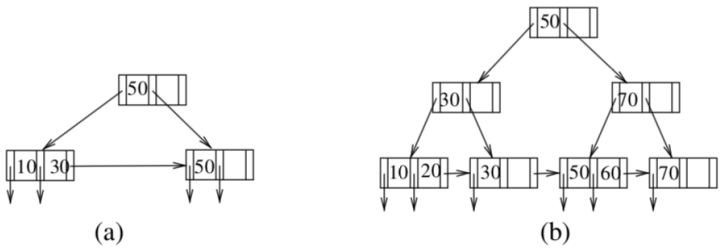
2. This problem is based on an E/R design for a database used in a manufacturing company shown in Figure 1. This database stores information about parts. Each part has a part number, which uniquely identifies the part. A part may in fact be an assembly, which consists of some number of one or more subparts. For example, a bicycle might be described as an assembly consisting of one frame and two wheels; a frame is just a basic part; a wheel is an assembly consisting of one tire, one rim, and 48 spokes. Each assembly is also associated with the cost of assembling its subparts.

   Convert the E/R diagram to relations. For the translation of subclasses, assume that we generate multiple tables for specialization and that a subclass does not inherit non-key attributes from its superclass. The text does not properly discuss the circle: it just means an "attribute of an entity set."



Part 3: Seeing the Forest for the Trees

Consider the following two B+trees for this problem. You may need to review chapter 11, or the lecture slides.



1. Show the final B+tree structure after we insert 60, 20, and 80 into Figure (a) in the given order.
2. Show the final B+tree structure after we delete 20, 10, and 70 from Figure (b) in the given order.