Carnegie Mellon University

15-415 Database Applications

Spring 2012, Faloutsos

Assignment 6: Schema Refinement

Due: ~~**3/27**~~ **3/29**, 1:30 pm, in class – **hard copy**

Reminders

- Weight: **5%** of the homework grade.
- The points of this homework add up to **100**.
- Lead TA: Bin Fu (binf@andrew.cmu.edu).
- Please **type** all your answers.
- Rough time-estimates: **2~4 hours**.
- The textbook referred to in the homework is Database Management Systems by Ramakrishnan and Gehrke, 3rd edition.

Question 1: Functional dependency examples [6 points]

Consider the relation shown in the following table:

X	Y	Z
x_1	y_1	z_1
x_2	y_1	z_2
x_1	y_2	z_2
x_2	y_1	z_2

List all the functional dependencies that this relation instances satisfy.

Question 2: Functional dependency deductions [24 points]

Consider the following set S of functional dependencies:

A -> C (F1)

BD -> A (F2)

C -> B (F3)

For each of the following dependencies, if it can be deduced from S, give the rigorous proof; if not, give a counter-example with 3 tuples or less.

[Q2.1] CD -> A [**8 points**]

[Q2.2] BC -> A [**8 points**]

[Q2.3] AD -> B [**8 points**]

Question 3: Related Concepts I [20 points]

Consider the relation schema R(A, B, C, D) with functional dependencies A->D, B->CD and AC->D.

[Q3.1] Find the attribute closure $\{A\}^+$. [**5 points**]

[Q3.2] Find the attribute closure $\{A, B\}^+$. [**5 points**]

[Q3.3] Find the minimum cover (i.e. canonical cover) of the given functional dependencies. [**5 points**]

[Q3.4] List all the candidate key(s) of R. [**5 points**]

Question 4: Decompositions [15 points]

Consider the relation schema R(A, B, C, D, E, G) with functional dependencies F = {AB->C, AG->E, B->D, E->G}. Notice F is the minimum cover of itself.

For each of the following decompositions R(A, B, C, D, E, G), determine whether it is (a) dependency-preserving, and (b) lossless.

i) {ABC, CDE, EG} [**5 points**]

ii) {ABCD, AEG} [**5 points**]

iii) {ABCE, BD, AEG} [**5 points**]

Question 5: BCNF and 3NF [35 points]

Consider the relation schema R(A, B, C, D) with functional dependencies A->B, BC->A and B->D, which is the minimum cover itself.

[Q5.1] Find all the candidate key(s) of R. [**5 points**]

[Q5.2] Is relation R in BCNF? Is it in 3NF? Justify your answers. [**10 points**]

[Q5.3] Decompose the relation R(A, B, C, D) into a collection of BCNF relations, so that the decomposition is lossless. Please follow the instructions on section 19.6.1 of the textbook (R+G, 3rd edition, p622). Is the decomposition dependency-preserving? [**10 points**]

[Q5.4] Decompose the relation R(A, B, C, D) into a collection of 3NF relations, so that the decomposition is both lossless and dependency-preserving. Please follow the instructions on page 627 of the textbook. [**10 points**]