

Carnegie Mellon University
15-415 Database Applications
Spring 2006

Homework 6 – due Mon 4/17 at 3pm in class

Notes:

- This homework is worth 6% of the overall assignment grade
- This homework is to be done individually, **NOT IN GROUPS**
- Answers should be neatly written on paper and submitted. Illegible handwriting may get 0 points, at the discretion of the grader
- Contact shashank@cs.cmu.edu in case of any doubts

1 Functional Dependencies [50pts]

In this problem, we will visit the basics of functional dependencies – their definition, Armstrong’s axioms, and closures.

1.1 Detecting Functional Dependencies [10pts]

A	B	C	D	E
4	7	22	48	1
5	6	22	49	7
5	7	24	53	9
3	2	10	23	8
6	0	12	30	3
3	2	10	23	0
2	3	10	22	9
5	1	12	29	1
5	6	22	49	2

Table 1: An Instance of a Relational Schema $ABCDE$

Table 1 shows an instance of the relational schema $ABCDE$. Do the following functional dependencies hold or not? Please mention a brief reasoning for the answer that you provide. [2pts each]

1. $A \rightarrow CD$
2. $AC \rightarrow B$
3. $AB \rightarrow CDE$
4. $CD \rightarrow AB$
5. $BD \rightarrow CE$

1.2 Armstrong's Axioms [20pts]

The following FDs hold over the relational schema $ABCDE$: $A \rightarrow BC$, $C \rightarrow AD$, $B \rightarrow ED$, $AD \rightarrow E$. Can the following FDs can be inferred using Armstrong's axioms? If yes, show a step-by-step derivation (you can use union and decomposition as basic axioms in addition to reflexivity, augmentation and transitivity.) [4pts each]

1. $A \rightarrow D$
2. $AB \rightarrow CD$
3. $AE \rightarrow B$
4. $C \rightarrow E$
5. $D \rightarrow BC$

1.3 Closure [20pts]

For the schema and set of FDs given in Section 1.2, compute the attribute closures A^+ , B^+ , C^+ , D^+ , E^+ . Show a step-by-step execution of your algorithm for computing the closures. [4pts each]

2 Normal Forms [50pts]

In this question, we will visit the basics of schema normalization. Consider the schema $ABCDEF$ with the following dependencies:

$AC \rightarrow E$
 $BE \rightarrow D$
 $F \rightarrow CE$

2.1 Decompositions [20pts]

Check whether the following decompositions are (a) in BCNF, (b) lossless, and (c) dependency-preserving (mention a brief reasoning behind your answer): [5pts each]

1. $ABCE, DEF$
2. $ABCEF, BED$
3. $ABEDF, FCE$
4. ABF, FCE, BED

2.2 BCNF [30pts]

There are at least three possible BCNF decompositions for the given schema under the given dependencies. Find as many as you can, and for each decomposition mention if it is dependency-preserving or not. If not, mention the dependencies that are not preserved.