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CS 442

Assignment 5

I pledge my honor that I have abided by the Stevens Honor System.

1. To find the candidate keys, we separate the attributes into three categories, as shown below:

|  |  |  |
| --- | --- | --- |
| L (attributes that only show up on left side of FDs) | M (attributes that show up on both sides of FDs) | R (attributes that show up only on right side of FDs) |
|  | A, B, C, D | E |

We consider first the key of all attributes in the L column, but there are none. Then, we check all subsets of M. I will start with C+, the closure of C:

Because C -> A and C -> D is given, and C -> C is implied, then A, D, and C ∈ C+.

Because C -> D and D -> B, by transitivity, C -> B, so B ∈ C+.

Because C -> D and C -> C implies C -> CD, and CD -> E, C -> E by transitivity, so E ∈ C+.

Thus, C+ = { A, B, C, D, E }, and C is a candidate key.

Next, A+. A+ is only { A }, as A does not show up by itself on any LHS of the FDs.

Next, B+. B+ is only { B }, as B does not show up by itself on any LHS of the FDs.

Next, D+. D -> B is the only applicable option, so D+ = { D, B }.

Next, AB. AB -> C, and C is a candidate key, so AB+ = { A, B, C, D, E }, and AB is a candidate key.

Next, AD (skip AC because it is a superkey). AD -> AD, so AD -> A by decomposition.  
Because AD -> B and AD -> A, AD -> AB by union. Because AB is a candidate key, the AD+ = { A, B, C, D, E }. AD is a candidate key.

We do not consider any supersets including E, and all remaining supersets are supersets of existing candidate keys. Therefore, we stop here.

**The candidate keys are C, AB, and AD.**

1. To prove F is a superkey of R, F+ must equal { A, B, C, D, E, F }.

Because F -> E is given, and F -> F is implied, E and F ∈ F+.

Because F -> AD (given) implies F -> A and F -> D by decomposition, A and D ∈ F+.

Because F -> AD and AD -> B (given), F -> B by transitivity, and B ∈ F+.

Because F -> B and F -> A (established), F -> AB by union, and because AB -> C (given), F -> C by transitivity and C ∈ F+.

**Therefore F+ = { A, B, C, D, E, F }, and F is a superkey.**

1. To determine if BCNF is satisfied, we must first find all candidate keys of the relation.

|  |  |  |
| --- | --- | --- |
| L (attributes that only show up on left side of FDs) | M (attributes that show up on both sides of FDs) | R (attributes that show up only on right side of FDs) |
| StudNo, CourseNo, | Major, Advisor, InstrucName | Ctitle, StudName, InstrucLocn, Grade |

Using the same method as above, we first consider the key of all elements in L.

{StudNo, CourseNo}+ = {StudNo, CourseNo, StudName, Ctitle, InstrucName, InstrucLocn} (all given)

This is not a candidate key, so we consider the superset of all elements of L with some elements in M.

First, {StudNo, CourseNo, Major}:

{StudNo, CourseNo, Major}+ = {StudNo, CourseNo, Major, StudName, Ctitle, InstrucName, InstrucLocn, Advisor, Grade}

This is a candidate key.

Next, {StudNo, CourseNo, Advisor}:

{StudNo, CourseNo, Advisor}+ = {StudNo, CourseNo, Advisor, StudName, Ctitle, InstrucName, InstrucLocn, Major, Grade}

This is a candidate key.

Next, {StudNo, CourseNo, InstrucName}:

{StudNo, CourseNo, InstrucName}+ = {StudNo, CourseNo, InstrucName, StudName, Ctitle, InstrucLocn}

This is not a candidate key.

Stop here because all other supersets are superkeys.

Then, we should look at every table to see if any FD is not satisfied.   
First, we should decompose any possible FDs, so after decomposing FD2, we have the following FDs:

* 1. StudNo -> StudName
  2. CourseNo -> Ctitle
  3. CourseNo -> InstrucName
  4. InstrucName -> InstrucLocn
  5. StudNo, CourseNo, Major -> Grade
  6. StudNo, Major -> Advisor
  7. Advisor -> Major

In the Student table, the only applicable FD is (a), where StudNo is a candidate key. So, BCNF is satisfied in this table.

In the StudMajor table, (f) and (g) are applicable. {StudMajor, Major} is a candidate key of this table, so this satisfies BCNF. However, {Advisor} is not a candidate key of this table, so this violates BCNF. This table should be decomposed into StudAdvisor(StudNo, Advisor) and MajorAdvisor(Major, Advisor). No other FDs apply to these tables.

In the StudCouse table, (b), (c), (d), and (e) are applicable. Starting with (e), this is a candidate key, so BCNF is satisfied. Moving on to (d), InstrucName is not a candidate key, so the table needs to be decomposed into Instruc(InstrucName, InstrucLocn) and StudCourse2(StudNo, Major, CourseNo, Ctitle, InstrucName, Grade).

Then, no other FDs apply to Instruc, but FDs (b) and (c) still apply to StudCourse2. Starting with (b), CourseNo is not a candidate key, so this table should be decomposed into CourseTitle(CourseNo, Ctitle) and StudCourse3(StudNo, Major, CourseNo, InstrucName, Grade). No other FDs apply to CourseTitle.

Then, (c) still applies to StudCourse3. CourseNo, is not a candidate key, so this table should be decomposed into CourseInstruc(CourseNo, InstrucName) and StudCourse4(StudNo, Major, CourseNo, Grade). Finally, no violating FDs apply to these tables.

**The final tables are:**

**MajorAdvisor(Major, Advisor)**

**StudAdvisor(StudNo, Advisor)**

**Student(StudNo, StudName)**

**Instruc(InstrucName, InstrucLocn)**

**CourseTitle(CourseNo, Ctitle)**

**CourseInstruc(CourseNo, InstrucName)**

**StudCourse4(StudNo, Major, CourseNo, Grade)**