The University of British Columbia

Computer Science 304

Midterm Examination

May 25, 2011

Time: 50 minutes   Total marks: 53

Instructor: Rachel Pottinger

Name ANSWER KEY _______________________ Student No_____________

(PRINT) (Last) (First)

Signature____

<u>This examination has 5 pages.</u>

<u>Check that you have a complete paper.</u>

This is a closed book, closed notes exam. No books or other material may be used.

Answer all the questions on this paper.

Give very **short but precise** answers.

State any assumptions you make

Work fast and do the easy questions first. Leave some time to review your exam at the end.

Good Luck

Question	Mark	Out of
1		8
2		15
3		14
4		16
Total		53

1. {8 marks} Consider the schema S(A, B, C, D, E) together with the functional dependencies:

   CDE→A
   A→B
   C→D
   DE→A

   Is S in BCNF? Why or why not? If not, decompose into a collection of BCNF relations using the method we used in class and the book and *circle the relations in your final answer*. *Show all your work.*

First, find the keys.

CDE+=ABCDE
A+=AB
C+=CD
DE+=DEAB
CE+=CEDAB

So CE is a key. Note that CDE is a superkey. There is no other key.
But A→B violates BCNF (note that CDE→A does NOT violate BCNF since CDE is a superkey of S).
So decompose into S1(A,B), S2(A,C,D,E)
S1 has two attributes, so it is in BCNF.
Look at S2. C→D holds in S2, but C is not a superkey of S2, so it is not in BCNF. Decomposing on C→D, yields S3(C,D), S4(A,C,E). S3 has two attributes, so it is in BCNF. S4 has no functional dependencies that violate BCNF (since CE is a key of S4), so it is in BCNF. Therefore, the final decomposition is:

S1(A,B), S3(C,D), S4(A,C,E)

2. {15 marks} Consider the schema R(A, B, C, D, E) together with the functional dependencies:

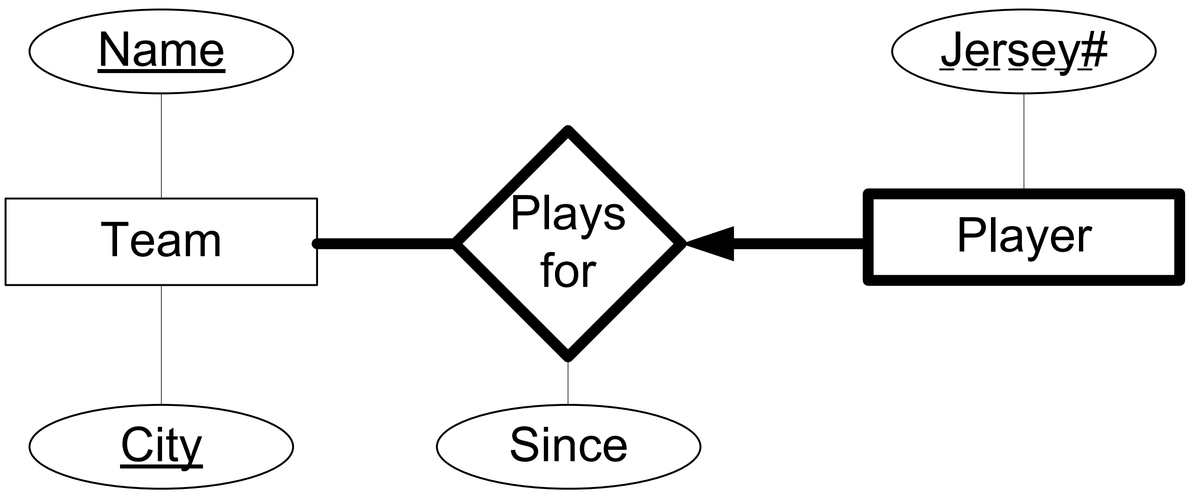
   BD → A
   AB→ C
   D→ A
   B→ C
   C→E

Is R in 3NF? Why or why not? If not, decompose into 3NF using the method we used in class and the book and *circle all relations in your final answer. Show all your work.*
AB+=ABCE
BD+=BDACE
D+=AD
B+=BCE
C+=CE
This question is isomorphic to question 2 from practice midterm 1 # 7
There is no way to get BD any other way, so BD is the only key. But the others do violate 3NF, so we need to decompose.

First we have to take the minimal cover. BD→A is redundant to D→A. AB→C is redundant to B→C. So the only functional dependencies to consider are D→A, B→C, and C→E. Note that because the cover only removes redundant functional dependencies, the original closures still holds. Start with D→A. D is not a key, so decompose: R1(A,D), R2(D,B,C,E). R1 is in BCNF since it is a two attribute relation. R2: B→C still holds, but B is not a key of R2, so decompose: R3(B,C), R4(B,D,E). R3 is in BCNF since it has only two attributes. R4 is not in BCNF since B→E holds in R4, but B is a key of R4. Decompose to R5(B,E), R6(B,D). All are two attribute relations, so all are in BCNF. At this point our answer set is R1(A,D), R3(B,C), R5(B,E), R6(B,D). Now, we consider if there are any functional dependencies that need to be added back in. D→A and B→C are both covered (R1 and R3 respectively). C→E is not. So we add in a new relation R5(C,E), bringing our final answer to R1(A,D), R3(B,C), R5(B,E),R6(B,D), R7(C,E)

3. (a){10 marks} Create the simplest ER diagram that you can that models the following specification:

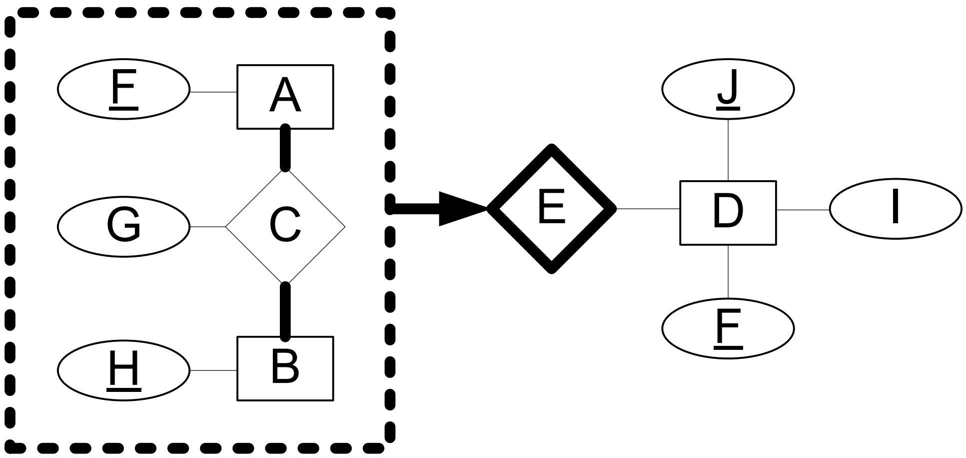
- A hockey team has multiple players
- Each team has a name and a home city. No two teams can have the same name and home city combination. We do not need to retain past home city or name information.
- A player can only play for one team (we do not retain past team information), and every player must be on a team
- Each player has a unique jersey number; the combination of the jersey number and the team information is unique
- Every team must have players
- We retain the date when the player last started playing for the team.



(b) {4 marks} If we modified the question so that we needed to retain all the dates that a player has been on each team (so that fairer bonuses can be made if they win the Stanley Cup), describe how you would modify your diagram, and what constraints, if any, you would have trouble expressing.

To retain all of the dates that a player has played on a team, we would need to create another entity, e.g., Duration, with attributes "to" and "from," which also participates in the "Plays for" relationship, since otherwise we would be unable to have a player play for a team more than once. However, in this case, we would run into trouble expressing the constraint that a player can only belong to one team at a time. Further, the key of "Player" would now be a problem, since more than one player can have the same jersey number across time.

4. {16 marks}



Transform the ER diagram into a relational schema using the methods discussed in class/the book. If there are any conflicting attribute names, rename them something appropriate and easy to understand. State any assumptions that you make – but your assumptions cannot contradict the facts given.

a. {12 marks} What should the relational schema be? You do NOT have to create SQL DDL, just underline the keys and note foreign keys and not null constraints after the relation definition, e.g., you might have "M(<u>n</u>,o): foreign key (o) references R(q), o is not null"

First, consider the entities:
B(<u>H</u>)
A(<u>F</u>)
D(I,<u>F,J</u>)
Then the simple relationship:
C(<u>F</u>,<u>H</u>,G): foreign key (F) references A(F), foreign key (H) references B(H)

Finally, the aggregated weak entity. Because E is a weak entity relationship, then we combine the relationship C (since that's forming the "entity" part of the weak entity) with the relationship E to form table CE(<u>F</u>, <u>H</u>, <u>D-F</u>,G,<u>J</u>): foreign key (F) references A(F), foreign key (H) references B(H),foreign key (D-F,J) references D(F,J)

Note that the table C does not appear in the final answer because it has been subsumed by CE.

b. {4 marks} Are there any constraints in the relational schema that cannot be modeled without using assertions? If so, which constraint(s)? If not, why not?

The constraint that A and B are total in C cannot be represented without assertions.