CS411 Database Systems
Fall 2007

Midterm Solution

Problem 1

(1) False; (2) True; (3) True; (4) False; (5) True;
(6) False; (7) False; (8) False; (9) False; (10) True;
(11) False; (12) False; (13) True; (14) False;

Problem 2

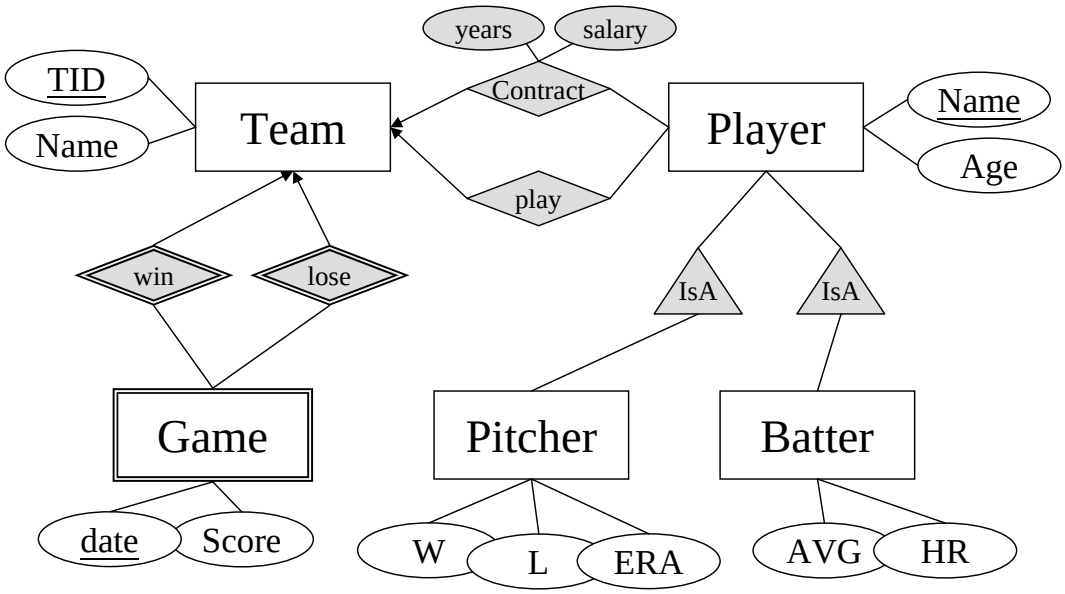

Figure 1: ER Diagram

Problem 3

Consider a relation $\mathsf{R}(\mathsf{A}, \mathsf{B}, \mathsf{C}, \mathsf{D}, \mathsf{E})$, with given FD's $\mathsf{AB} \rightarrow \mathsf{C}$, $\mathsf{BC} \rightarrow \mathsf{D}$, $\mathsf{CD} \rightarrow \mathsf{E}$, $\mathsf{DE} \rightarrow \mathsf{A}$.

(i) Determine all the keys of R.
(Hint: There are three keys and you don't not need to list superkeys that are not keys)
Answer: AB, BC, and BDE. Note that B must be in any key, since it doesn't appear on the right of any FD. That fact makes the search for keys fairly easy.

(ii) List which FDs violate 3NF if any.
None violate 3NF, because all attributes are prime.

(iii) List which FDs violate BCNF if any.
Answer: $\mathsf{CD} \rightarrow \mathsf{E}$ and $\mathsf{DE} \rightarrow \mathsf{A}$ violate BCNF.

(iv) Decompose R using BCNF decomposition. Indicate your working and summarize your final set of relations.
Answer: Suppose we use $\mathsf{CD} \rightarrow \mathsf{E}$ to decompose. Since $\{CD\}^+ = ACDE$, one of the schemes is $\mathsf{R1}(\mathsf{A}, \mathsf{C}, \mathsf{D}, \mathsf{E})$ and the other is $\mathsf{R2}(\mathsf{B}, \mathsf{C}, \mathsf{D})$. The latter is in BCNF, since BC is the only key, and $\mathsf{BC} \rightarrow \mathsf{D}$ the only projected FD. However, R1 is not in BCNF. For example, $\mathsf{DE} \rightarrow \mathsf{A}$ is a projected FD, but $\{DE\}^+ = ADE$, so DE is not a superkey for R1. Thus, we decompose R1 into $\mathsf{R3}(\mathsf{A}, \mathsf{D}, \mathsf{E})$ and $\mathsf{R4}(\mathsf{C}, \mathsf{D}, \mathsf{E})$. The constituents of the decomposition are R2, R3, and R4.

Problem 4

(i) $\pi_{Name}(Student \bowtie (\rho_{TeamName=\text{'BEE'}}ProjectTeam))$

(ii) $\pi_{UIN}Student - \pi_{UIN}ProjectTeam$

(iii) $\pi_{TeamName}ProjectTeam - \pi_{TeamName}(ProjectTeam \bowtie \sigma_{Department\neq\text{'CS'}}Student)$

(iv) $\pi_{Name}(Student \bowtie (Midterm - \pi_{UIN,Grade}(Midterm \bowtie_{Grade<Grade1} \rho_{M2(UIN1,Grade1)}Midterm)))$

Problem 5

(i)
```
SELECT Customer.cname
FROM Buy, Customer, Book
WHERE Customer.cid = Buy.cid AND Customer.state = 'Illinois' AND
       Buy.isbn = Book.isbn AND Buy.year = 2000
GROUP BY Customer.cid
Having SUM(Book.price) > 5000;
```

(ii)
```
CREATE VIEW Sales AS
SELECT Author.assn, Author.aname, COUNT(Buy.tid) AS count
        FROM Author, Book, Buy
        WHERE Buy.isbn = Book.isbn AND
              Book.isbn = Author.isbn AND
              Buy.year = 2006
        GROUP BY Author.assn;

SELECT Author.aname
FROM Sales
WHERE Sales.count = (SELECT MAX(Sales.count)
                     FROM Sales);
```

(iii)
```
CREATE VIEW FriendsOfBob AS
SELECT Buy.cid AS cid
FROM Buy
WHERE Buy.cid <> 12345 AND
      Buy.isbn IN (SELECT Buy.isbn
     FROM Buy
     WHERE Buy.cid = 12345)
GROUP BY Buy.cid
HAVING COUNT(Buy.isbn) > 20;
```

(iv)
```
SELECT Buy.isbn
FROM FriendsOfBob, Buy
WHERE FriendsOfBob.cid = Buy.cid AND Buy.isbn NOTIN
(SELECT Buy.isbn
FROM Buy
WHERE Buy.cid = 12345);
```

Problem 6

(i)
1. $RemoteLikes(p, q) \leftarrow Likes(p, q)$ AND NOT $Dislikes(p, q)$
2. $RemoteLikes(p, q) \leftarrow RemoteLikes(p, r)$ AND $RemoteLikes(r, q)$ AND NOT $Dislikes(p, q)$

(ii) There is only one IDB predicate, *RemoteLikes*, and there is no negative self-loop arc on it although there is a positive self-loop arc. Therefore, negation in rules in Problem 6(i) is stratified.