CMSC 661 FINAL EXAMINATION

12/19/96

This exam is open book. Please write your name and SSN on the first page of all exam books. You have 120 minutes to do all of the questions whose points sum to 100. Grades will be available on January 2, 1997 and posted outside my door. Good luck.

Thought for the day: *"The trouble with the world is that the stupid are cocksure and the intelligent are full of doubt."* – Bertrand Russell.

1 Functional Dependencies (10)

Given a relation R(A,B,C,D) with the following functional dependencies

$A \longrightarrow B$
$AB \longrightarrow D$
$D \longrightarrow C$
$AC \longrightarrow B$
$B \longrightarrow C$

1. What is a minimal set of dependencies for R? The *minimal set of dependencies* is the set of dependencies in which right hand sides consist of a single attribute, no functional dependency can be removed, and no attribute can be removed from the left hand side of a functional dependency.

2. What is the set of candidate keys for R?

3. Which functional dependencies in the original set are violated in the following instance of R:

A	B	C	D
a1	b1	c1	d1
a1	b2	c1	d2

2 SQL One (15)

You are given relation store(storeName,sales,storeCity) where *storeName* forms a key. Consider the following SQL query:

```
SELECT T.storeName
FROM store T, store S
WHERE T.storeCity='Baltimore' and
      S.storeCity='Baltimore' and
      T.sales > S.sales
```

1. State in English what this query does.

2. Write a relational algebra expression that is equivalent to this query; make it efficient in the sense that the size of the intermediate results is as small as possible.

3. State an equivalent SQL query that produces the same result but more efficiently than the one above.

3 Locking (20)

Consider the following schedule of four transactions T1, T2, T3, T4} in which *rl(X)* represents a request for a read lock on data item X, *wl(X)* represents a request for a write lock on data item X, and *ul(X)* represents a release of all of that transaction's locks on X. You may that assume that a "read" action occurs when the read lock is obtained, and that "read" and "write" actions occur when the write lock is obtained.

time	**T1**	**T2**	**T3**	**T4**
1		rl(A)		
2		wl(B)		
3		ul(A)		
4			wl(A)	
5		ul(B)		
6	rl(B)			
7			ul(A)	
8				rl(B)
9	rl(A)			
10				ul(B)
11	wl(C)			
12	ul(A)			
13				wl(A)
14				ul(A)
15	ul(B)			
16	ul(C)			

1. Draw the precedence graph for this schedule.

2. Find an equivalent serial schedule, or explain why one doesn't exist.

3. Define what it means for a transaction to be "well-formed". Which transactions (if any) are not well-formed?

4. Define what it means for a transaction to be "two-phased." Which transactions (if any) are not two-phased?

5. Define "legal schedule." Is this schedule legal?

6. What implications does the Two-Phase Locking Theorem have on possible concurrent executions of these four transaction.

4 Timestamps (15)

Consider the schedule from the previous question, and now suppose we are using timestamp-based concurrency control. We can reinterpret the operations above as if *rl(X)* represents the action of reading data item X, *wl(X)* represents the action of reading data item X, and *ul(X)* is eliminated, resulting in:

time	**T1**	**T2**	**T3**	**T4**
1		read(A)		
2		write(B)		
3				
4			write(A)	
5				
6	read(B)			
7				
8				read(B)
9	read(A)			
10				
11	write(C)			
12				
13				write(A)

1. Assume that the timestamps of T1, T2, T3, and T4 are respectively 300, 310, 320 and 330. Which, if any, of the four transactions abort?
2. Is there any assignment of timestamps to these transactions which could have produced the above schedule, i.e. in which none of the transactions would have aborted? If so, give the ordering; if not, explain why not.

5 Datalog to Relational Algebra (10)

Given two relations R, of arity two, and S, of arity 1, and the following Datalog program which computes two arity 1 relations P and Q.

p(x) :- r(X,Y) & ¬ s(Y).
q(Z) :- s(Z) & ¬ p(Z).

Write a relational algebra expression for Q, using R and S.

6 SQL two (20)

Consider a database of carnival rides and their rating (an integer from 1 to 10, with 1 being very safe and 10 being life threatening), children and the maximum rating that they are allowed to ride, and the rides that each child likes.

rides(ride,rating)
children(child,max)
likes(child,ride)

Write SQL expressions for each of the following queries.

1. Print the number of rides for each rating.
2. Print all pairs (RIDE, CHILD) where the child is allowed on the ride and the child likes the ride.
3. Print the children who like some ride that they are not allowed to go on.
4. Print the names of children who like no ride that they are allowed to go on.

7 Decompositions (10)

Given a relation R(A,B,C,D,E) where the following functional dependencies hold

$A \longrightarrow BC$
$CD \longrightarrow E$
$B \longrightarrow D$
$E \longrightarrow A$

consider the decomposition of R into R1(A,B,C) and R2(A,D,E).

1. What are the candidate keys for R.
2. Is this decomposition lossless? Justify your answer.
3. is R2 in BCNF?
4. Does this decomposition preserve dependencies?