浙江大学 2018 年

《数据库系统》期末考试题

Problem 1：Relational Model and SQL（15 points，3 points per part)

Following relational schemas represent information of a campus card database in a university.

card(cno:char(5), name:char(8), depart:char(10), balance:integer)
pos(pno:char(4), campus:char(8), location:char(10))
detail(cno:char(5), pno:char(4), cdate:date, ctime:time, amount:integer, remark:char(10))

Following tables show an instance of the database:

card

cno	name	depart	balance
c0001	张帅	CS	100
c0002	李丽	EN	200
c0003	王浩	CS	300
c0004	刘萌	CS	400
c0005	赵亮	MA	500

pos

pno	campus	location
p001	玉泉	教育超市
p002	玉泉	四食堂
p003	玉泉	四食堂
p004	紫金港	教育超市
p005	紫金港	教育超市
p006	紫金港	一食堂

detail

cno	pno	cdate	ctime	amount	remark
c0001	p002	2018-07-01	08:10:10	6	餐饮
c0001	p002	2018-07-01	12:05:12	12	餐饮

c0001	p002	2018-07-01	17:30:20	20	餐饮
c0001	p001	2018-07-01	18:10:10	60	购物
c0002	p002	2018-07-02	08:10:10	8	餐饮
c0002	p001	2018-07-02	08:10:10	20	购物
c0003	p003	2018-07-02	08:10:10	25	餐饮

Given following SQL query on above relations：

```
select cno, name
from card natural join detail
where depart= 'CS' and (cdate , pno) in
                    (   select cdate, pno
                        from detail
                        where cno='c0002' )
```

Please answer following questions：

(1) Transform above query to a SQL statement without nested subquery.

(2) Transform above query to an equivalent relational algebra expression.

(3) Write a SQL statement to find out cards consumed in only one campus in 2018.

(4) Write a SQL statement to find out the pos in "紫金港" campus that has the maximum total amount of card consumption in 2018.

(5) Write a sequence of SQL statements to complete following transaction:
card "c0002" consumes 20 at pos "p001" at 2018-07-02 08:08:08

Answers of Problem 1：

Problem 2：E-R Model （11 points)

Please design an ER diagram for a takeaway platform（外卖平台）to capture information about **restaurants**, **customers**, **couriers**（快递员）**, orders , payments,** and **deliveries,** etc. A **restaurant** sell **items** on the platform. A **customer** has several **addresses**. A **courier** delivers packages of order to customers.

Answers of Problem 2：

Problem 3: Relational Formalization(12 points, 3 points per part)

For relation schema R(A, B, C, D, E) with functional dependencies set F={A→CD, C→B, B→D, B→E}

(1) Compute the Canonical Cover of F.

(2) Compute the Closure of attribute set {B}.

(3) Decompose the relation R into a collection of BCNF relations, and give out the functional dependency set for each relation.

(4) Explain whether above decomposition be dependency preserving or not.

Answers of Problem 3：

Problem 4: XML(12 points, 4 points per part)

Following DTD depicts information of the campus card database given in **problem 1**:

```
<!DOCTYPE    campus_cards[
    <!ELEMENT    campus_cards( pos+,card+)>
    <!ELEMENT    pos (campus, location)>
    <!ATTLIST    pos pno ID #REQUIRED>
    <!ELEMENT    campus (#PCDATA)>
    <!ELEMENT    location (#PCDATA)>
    <!ELEMENT    card (name, depart, balance, detail*)>
    <!ATTLIST    card cno ID #REQUIRED>
    <!ELEMENT    name (#PCDATA)>
    <!ELEMENT    depart (#PCDATA)>
    <!ELEMENT    balance (#PCDATA)>
    <!ELEMENT    detail (cdate, ctime, amount, remark)>
    <!ATTLIST    detail pno IDREF    #REQUIRED>
    <!ELEMENT    cdate (#PCDATA)>
    <!ELEMENT    ctime (#PCDATA)>
    <!ELEMENT    amount (#PCDATA)>
    <!ELEMENT    remark(#PCDATA)>
]>
```

(1) Base on the instance of the campus card database given in **problem 1**, give an XML document that conforms to above DTD. The document is required to contain the information of **pos "p003"** and **card "c0003"** as well as its consumption details.

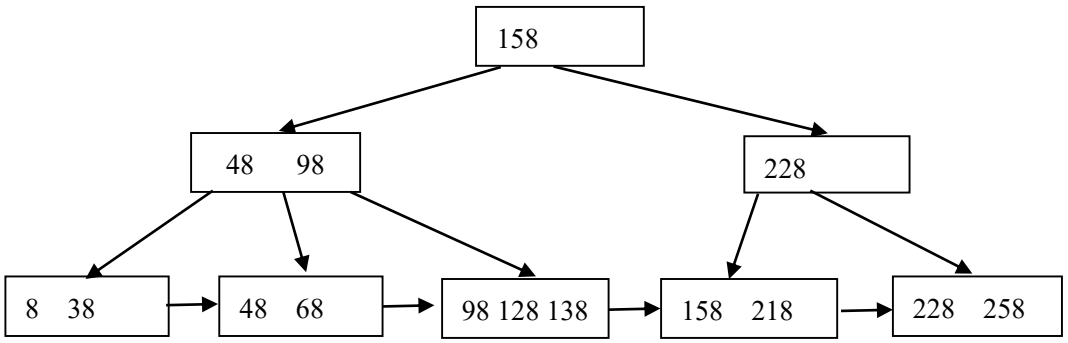
(2) Give a Path expression to find out the **location** of **pos** where 张帅 once paid 50.

(3) Give an XQuery expression to find out the **cno** of **card** that once paid at the same **pos** and **date** with 张帅.

Answers of Problem 4：

Problem 5: B+ -Tree (12 points, 4 points per part)

For the following B+-tree (n=4)：



(1) Draw the B+ -tree after inserting four entries 28,168, 58,18 sequentially.
(2) Draw the B+ -tree after deleting four entries 8, 38, 98,128 from the original B+-tree sequentially.
(3) Assuming (a) there are 3 blocks in main memory buffer for B+-tree operation, at first these blocks are empty. (b) Least Recently Used (LRU strategy) is used for buffer replacement. (c) each node of B+-tree occupies a block.
Please count the number of B+-tree blocks transferred to buffer in order to complete the operation in 1).

Answers of Problem 5：

Problem 6: Query Processing (16 points, 4 points per part)

For the relational schemas of the campus card database given in **problem 1**, there are following assumptions:

- n_{card}=10,000 , n_{pos}=100, n_{detail}=10,000,000
- l_{card}=25, l_{pos}=22, l_{detail}=29
- V(campus, pos) = 6, V(location, pos) = 20
- V(depart, card) = 100, V(name, card) = 5000
- The value of attribute **cdate** in **detail** table is uniformly distributed between '2017-01-01' and '2017-12-31'.
- block size is 4K bytes.
- size of B+-tree pointer is 4 bytes.
- **card** and **detail** tables are stored as sequential files based on search key **cno**.
- there is a B+-tree index on **detail(cno)**.

(1) Estimate the size (i.e. number of records) returned by following SQL statement :

```
select d1.cno, d2.cno
from detail d1, detail d2
where d1.pno=d2.pno and d1.cdate=d2.cdate and
      d1.cdate between '2017-05-01' and "2017-07-31'
```

(2) Estimate the number of blocks of **card** and **detail** tables respectively.

(3) Estimate the height of the B+-tree index on **detail(cno)**.

(4) Estimate the cost for evaluating expression "$\sigma_{name='张帅'}$**(card)** $\bowtie$ **detail** " using file scan for σ operation followed by indexed-loop join method for $\bowtie$ operation.

(Hind: the cost is measured by number of blocks transferred to main memory and times to seek disk.)

Answers of Problem 6：

Problem 7: Concurrency Control (12 points，3 points per part)

Consider following schedule S with five transactions T1,T2,T3,T4 and T5:

S: r1(A) w2(A) r2 (B) w3(A) w3(B) w4(C) w4(B) w5(C) w3(C)

where: ***ri(X)*** means transaction ***Ti*** read data ***X***.

wi(X) means transaction ***Ti*** write data ***X***.

(1) Draw the precedence graph of S.
(2) Explain whether S is serializable.
(3) Explain whether S be generated by the two–phase locking protocol.
(4) If S is serializable, give out all serial schedules to which S is equivalent. If S is not serializable, figure out an operation in S such that if this operation was removed from S，S would become serializable.

Answers of Problem 7：

Problem 8: Aries Recovery Method (10 points, 2 points per part)

A DBMS uses **Aries** algorithm for system recovery. Following figure is a log file just after system crashes. The log file consists of 16 log records with LSN from 1001 to 1016. The figure does not show PrevLSN and UndoNextLSN in log records. Assuming that last completed checkpoint is the log record with LSN 1012.

1001： <T1 begin>

1002： <T1 , 8001.1, 11, 22>

1003： <T2 begin>

1004： <T2 , 8001.2, 33, 44>

1005： <T3 begin>

1006： <T3, 8002.1, 55, 66 >

1008： <T1 commit>

1009： <T4 begin>

1010： <T4, 8001.1, 22, 77 >

1011： <T2, 8002.2, 88, 99>

1012： checkpoint

Txn	LastLSN
T2	1011
T3	1006
T4	1010

PageID	PageLSN	RecLSN
8001	1010	1010
8002	1011	1006

1013： <T2 commit>

1014： <T3, 8002.1, 66, 77>

1015： <T4, 8003.1, 11, 22>

1016： <T4 commit>

Please answer following questions：

(1) Which log record is the start point of Redo Pass?
(2) Which log record is the end point of Undo Pass?
(3) After Analysis Pass，what content is the dirty page table?
(4) After recovery, what is the value of data items identified by “8002.1” and “8002.2” respectively?
(5) After recovery, what additional log records appended to log fie?

Answers of Problem 8: