CS425 FINAL EXAM
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Relational Algebra Key
$E \leftarrow \Pi \bowtie \sigma G$
$\Pi = Projection$
$\bowtie = Natural\ Join$
$\sigma = Select$
$G = Aggregate$
$\wedge/\vee = and/or$

I, Tiffany Wong, will work on my own on the exam and I will not share my answers or discuss it with anyone even after completing the exam.
X Tiffany Wong, Signature

Hints: part p_id is the primary key for part. Part relation includes the part information and their suppliers.
Inventory tables lists the parts, their quantities and warehouse_id they are stored in. Both p_id and warehouse_id form the primary key. p_id reference the part relation.
The customer table stores the customer information and uses c_id as primary key.
The model table includes the Model name and the part it constitutes. It uses Model and p_id as primary key. p_id reference the part relation. A model includes many parts and a part can be used on many models.
Order includes all the order's information, what Model customer orders, how many units and which year they place the order in. c_id reference the customer relation.

I. Relational Algebra (6 points) (in handwritten portion attached at the end)

1. (2 points) Write a relational algebra expression that returns the p_id of the unavailable parts (are not in stock) and their quantities that are used for building the first order (order_id i 1). This query helps understand what parts are missing from order1.

(in handwritten portion attached at the end)

2. (2 points) Write a relational algebra expression that returns p_id and the cost of the parts used for building an SD70Ace model.

(in handwritten portion attached at the end)

3. (2 points) Write a relational algebra expression that returns the model (s) whose parts in stock are less than 10% of its overall parts (overall parts is the count of different parts in the model)

(in handwritten portion attached at the end)

II. SQL (total 9 points)

1. (1.5 points) Write an SQL statement that create a new table supplier that stores the supplier's name and the p_id, c_id, location, and sale price. The primary key being the combination of p_id and c_id. The sale price must be positive. No p_id can be left blank. When a part is deleted from the part table it must be removed from supplier table.

```
create table supplier (
	supplier_name varchar(20),
	p_id int not null,
	c_id varchar(20),
	location varchar(20),
	sale_price money check(0<=sale_price) ,
	primary key (p_id, c_id),
	foreign key (p_id) references part(p_id) on delete cascade,
	foreign key (c_id) references order(c_id)
);
```

2. (1.5 points) Write an SQL query that returns the names of all the customers that bought either 'SD70Ace' or ' SD70 ACs' models.

```
select customer.name
from customer join orders
where orders.model = 'SD70Ace' or orders.model=' SD70 ACs';
```

3. (2 points) Write an SQL query that return the p_id needed for building models bought by 'CN.'

```
select p_id
from customer join orders on customer.c_id=orders.c_id
	join model on orders.model=model.model
where customer.c_id='CN';
```

4. (2 points) create a view average, that includes the average order size (average number of units) per customer for each model.

```
create view average(average_order_size) as
        select customer.name, avg(nbUnit),
        from orders join customer
        group by model;
```

5. (2 points) Write an SQL operation to increase parts price by 10% for US supplier and 15% for international suppliers.

```
update part
set part.cost = CASE supplier
WHEN 'US' THEN part.cost = part.cost*1.1
ELSE part.cost = part.cost*1.15;
```

III. Normalization (6 points) (work is in hand written portion)

Consider the following relation R(A, B, C, D, E, F) and functional dependencies F that hold over this relation.

B → A, C

C → D, B

F → E

B, A → F

1. (1.5) Determine all the candidate keys.

{BC}

(work is in hand written portion)

2. (1.5) Find the closure of {AD}

{AD}+ = AD

(work is in hand written portion)

3. (1.5) Find the closure of F.

{F}+ = EF

(work is in hand written portion)

4. (1.5 points) Is R in BCNF if not please decompose R in Ri where Ri is the sub relation.

R is not in BCNF.

R1(EF)

R2(ABCDF)

(work is in hand written portion)

IV. Transaction (4.5 points)

For each of the following schedules determine which properties this schedule has. E.g., a schedule may be recoverable and cascade-less. Please justify your answer.

Consider the following notation for operations of transactions:

w1(A) transaction 1 wrote item A

r1(A) transaction 1 read item A

c1 transaction 1 commits

a1 transaction 1 aborts

1. (2.5 points) S1 = r3(B), w3(C), r1(B), w1(D), w2(A), r2(C), w4(A), c2, c4, r3(D), c3, c1
2. (2 points) S2 = r3(C), w1(A), r2(B), w3(B), c3, w1(C), c1, r2(A), w2(B), c2

1. S1

non-recoverable because t2 reads C from t3's write into C and committed before t3's commit
not cascadeless because t2 reads C from t3's write into C and committed before t3's commit
view-serializable because it is view equivalent to its serial schedule
conflict-serializable because it doesn't have a commit after writing in any of the transactions

2. S2

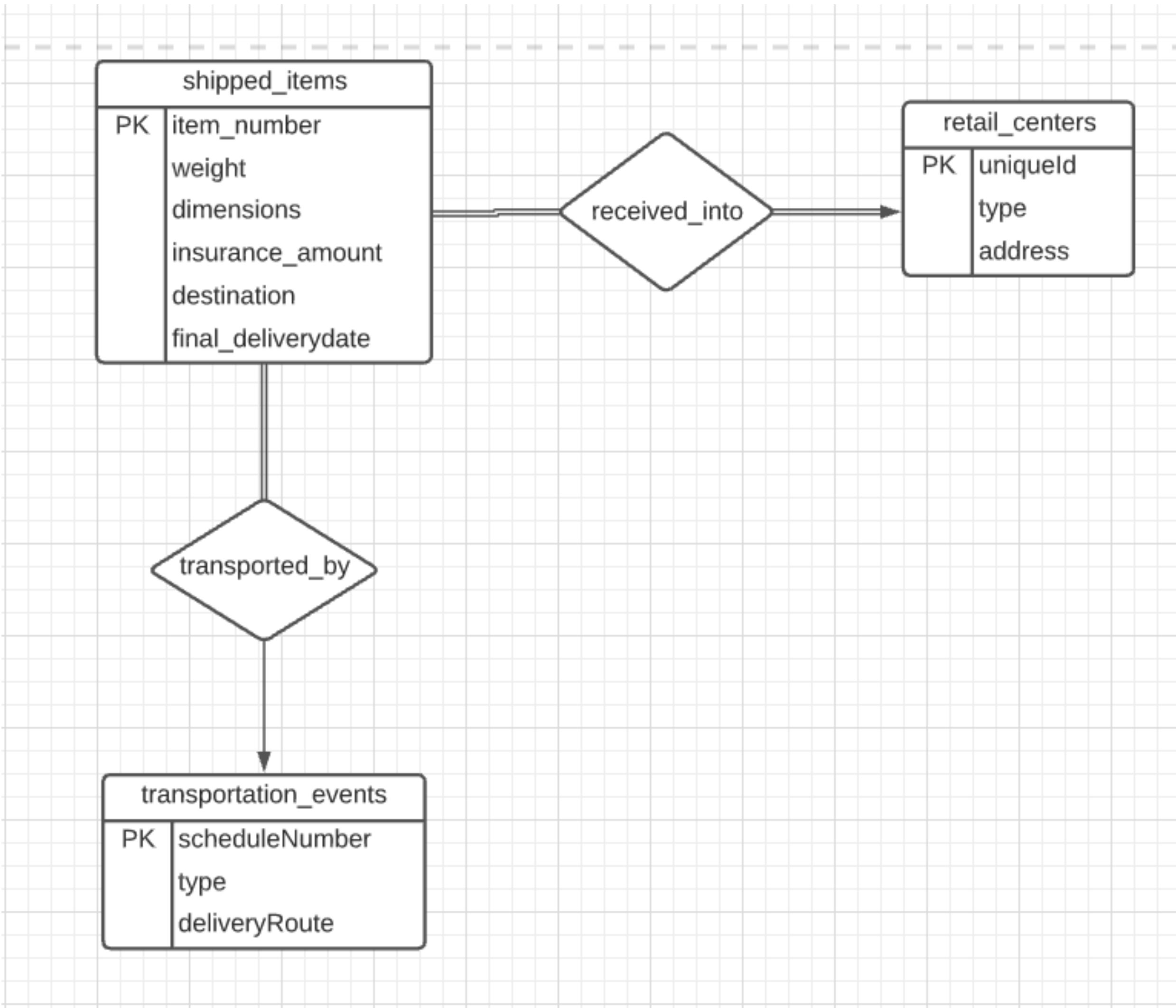
recoverable because all reads are before committing in another transaction
cascadeless because there's no error when there's a failure in one of the transactions at any point before and after committing the transaction
not view-serializable because it is not view equivalent to its serial schedule
not conflict-serializable because its conflict graph is cyclic

V. ER (4.5 points)

Shipping company-wide information system includes the follow:

Shipped items are the heart of the product tracking information system. Shipped items can be characterized by item number (unique), weight, dimensions, insurance amount, destination, and final delivery date. Shipped items are received into the system at a single retail center. Retail centers are characterized by their uniqueID, type and address. Shipped items make their way to their destination via one or more standard transportation events (i.e., flights, truck deliveries). These transportation events are characterized by a unique scheduleNumber, a type (e.g, flight, truck), and a deliveryRoute. Some transportation many are not used. Please create an Entity Relationship diagram that captures this information about the system. Be certain to indicate identifiers and cardinality constraints.

1. (2.5 points) Create an ER diagram for the shipping company.



PLEASE NOTE:

- the arrow pointing to transporation_events is meant to indicate one or many !!
- transportations is not associated with every shipped_items !!
- all shipped_items are sent to one retail center!!

2. (2 points) Reduce the ER diagram to schema list the reduction rules to justify your answer.

Rule1) Translate strong entities + unnest composite attributes
shipped_items(<u>item_number</u>, weight, dimensions, insurance_amount, destination, final_deliverydate)
retail_centers(<u>uniqueID</u>, type, address)
transportation_events(<u>scheduleNumber</u>, type, deliveryRoute)

Rule2) Translate weak entities

none

Rule3) Translated multi-valued attributes
none

Rule4) Translate relationships
One-to-One:
none

One-to-Many:
transportation_events(<u>scheduleNumber</u>, type, deliveryRoute, item_number)
retail_centers(<u>uniqueID</u>, type, address, item_number)

Many-to-Many:
none

1. RELATIONAL ALGEBRA

(for theta join)
model.p_id = inventory.p_id

① $\pi_{p\_id,\ quantity}(\sigma_{order.order\_id = 1 \wedge inventory.quantity = 0}(Orders \bowtie Model \bowtie Inventory))$

orders.model = Model.model (for theta join)

② $\pi_{p\_id, cost}(\sigma_{Model = \text{'SD70Ace'}}(Part \bowtie_{part.p\_id = Model.p\_id} Model))$

③ $\pi_{Model.model}(\sigma_{current < 0.1 \cdot overall}\ Model \bowtie Inventory)$

$overall \leftarrow {}_{model}G_{count(p\_id)\ as\ overall}\ Model$

$current \leftarrow {}_{model}G_{count(p\_id)}(\sigma_{quantity > 0}(Inventory \bowtie_{inventory.p\_id = model.p\_id} Model))$

as current_amount

III. NORMALIZATION

① → look for the attributes that cannot be determined because then they should be present in the candidate keys (trivial)

$A^+ = A$
$B^+ = A, B, C, F$
$C^+ = C, D, B$
$F^+ = F, E$

> candidate keys

→ see if other attributes are required to find the set of candidate keys
↳ find closure of BDE
↳ check attributes that can be determined from this set

$(AF)^+ = AEF$ - no help

$\boxed{BC}$

② $(AD)^+ = AD$

③ $(F)^+ = FE$

④ violation in BCNF: $F \rightarrow E$ is not trivial
$F \rightarrow E$ does not have superkey on LHS of functional dependency

$\boxed{\text{NOT in BCNF}}$

→ split R into R1 = EF & R2 = ABCDF

→ restrictions of R1 & R2 by F

F1: $F \rightarrow E$
F2: $B \rightarrow C$, $C \rightarrow ABDF$

R1 (E, F)

R2 (ABCDF)