



1. ER Modeling

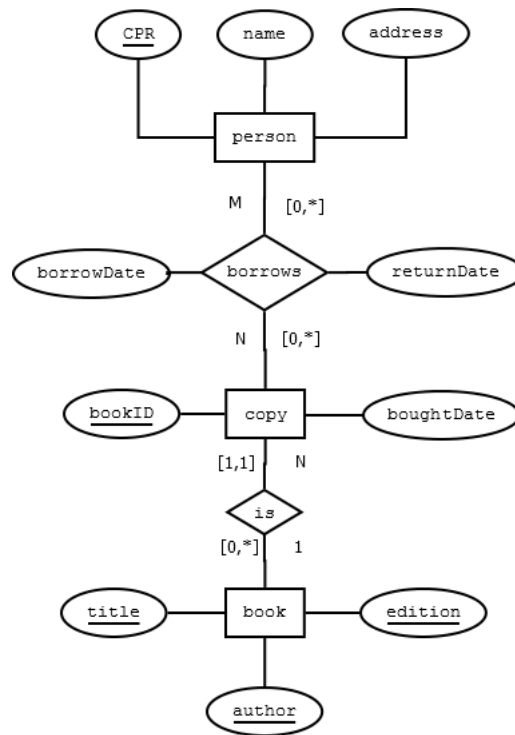


Figure 1: ER Diagram - Exercise 1

2. Banking System

phone

$\{[\underline{number}, provider, contract]\}$

has

$\{[\underline{number} \rightarrow phone, SSN \rightarrow customer]\}$

customer

$\{[\underline{SSN}, name, address]\}$

account

$\{[\underline{accountNumber}, type, balance, owner \rightarrow customer]\}$

statement

$\{[\underline{ID}, accountNumber \rightarrow account, date]\}$

3. Relational Algebra

1.

$\pi_{species, zooID}(animals)$

| species | zooID |
|---------|-------|
| giraffe | 1 |
| giraffe | 2 |
| giraffe | 3 |
| ape | 1 |
| ape | 2 |
| owl | 2 |
| owl | 1 |

$\sigma_{country='Germany'}(zoos)$

| zooID | name | city | country |
|-------|---------------|-----------|---------|
| 1 | Zoo Frankfurt | Frankfurt | Germany |

$\pi_{zooID}(\sigma_{country='Germany'}(zoos))$

| zooID |
|-------|
| 1 |

$(\pi_{species, zooID}(animals)) \div (\pi_{zooID}(\sigma_{country='Germany'}(zoos)))$

| species |
|---------|
| giraffe |
| ape |
| owl |

2.

$(\rho_{T1}(animals)) \bowtie_{T1.zooID=T2.zooID} (\rho_{T2}(animals))$

| T1.animalID | T1.nickname | T1.species | T1.gender | T1.zooID | T1.father | T1.mother | T2.animalID |
|-------------|-------------|------------|-----------|----------|-----------|-----------|-------------|
| 1 | Tally | giraffe | female | 1 | 3 | 2 | 1 |
| 1 | Tally | giraffe | female | 1 | 3 | 2 | 4 |
| 1 | Tally | giraffe | female | 1 | 3 | 2 | 7 |
| 1 | Tally | giraffe | female | 1 | 3 | 2 | 8 |
| 1 | Tally | giraffe | female | 1 | 3 | 2 | 10 |
| 1 | Tally | giraffe | female | 1 | 3 | 2 | 11 |
| 2 | Kathy | giraffe | female | 2 | - | - | 5 |
| 2 | Kathy | giraffe | female | 2 | - | - | 6 |
| ... | • | • | • | • | • | • | • |

Was too big. Going straight to result:

$\pi_{T1.nickname}(\sigma_{T1.animalID=T2.father \vee T1.animalID=T2.mother}((\rho_{T1}(animals)) \bowtie_{T1.zooID=T2.zooID} (\rho_{T2}(animals))))$

| T1.Nickname |
|-------------|
| Wohoo |
| Huhuu |
| Eule |

4. Relational Calculus



1.

$\pi_{sname}((Suppliers) \bowtie ((\sigma_{color='red'}(Parts)) \bowtie (Catalog)))$



$\{ \langle s.sname \rangle \mid s \in Suppliers \wedge \exists c (c \in Catalog \wedge c.sid = s.sid \wedge \exists p (p \in Parts \wedge p.pid = c.pid \wedge p.color = 'red')) \}$

$\{ \langle sname \rangle \mid \langle sid, sname, - \rangle \in Suppliers \wedge \langle sid, pid, - \rangle \in Catalog \wedge \langle pid, -, 'red' \rangle \in Parts \}$

2.

$\pi_{sid}((\sigma_{color='red' \vee color='green'}(Parts)) \bowtie (Catalog))$

$\{ \langle c.sid \rangle \mid c \in Catalog \wedge \exists p (p \in Parts \wedge p.pid = c.pid \wedge (p.color = 'red' \vee p.color = 'green')) \}$

$\{ \langle sid \rangle \mid \langle sid, pid, - \rangle \in Catalog \wedge (\langle pid, -, 'red' \rangle \in Parts \vee \langle pid, -, 'green' \rangle \in Parts) \}$

3.



$\pi_{sid}((Catalog) \bowtie ((\rho_{T1}(\sigma_{color='red'}(Parts))) \bowtie_{T1.pid=T2.pid} (\rho_{T2}(\sigma_{color='green'}(Parts)))))$

$\{ \langle c.sid \rangle \mid c \in Catalog \wedge \exists p1 (p1 \in Parts \wedge p1.color = 'red' \wedge c.pid = p1.pid \wedge \exists c1 (c1 \in Catalog \wedge c1.sid = c.sid \wedge \exists p2 (p2 \in Parts \wedge p2.pid = c1.pid \wedge p2.color = 'green')) \}$



$\{ \langle sid \rangle \mid \langle sid, pid, - \rangle \in Catalog \wedge (\langle pid, -, 'red' \rangle \in Parts \wedge \langle sid, pid', - \rangle \in Catalog \wedge \langle pid', -, 'green' \rangle \in Parts) \}$

4.



$\pi_{T1.sid, T2.sid}(\sigma_{T1.cost > T2.cost}((\rho_{T1}(Catalog)) \bowtie_{T1.pid=T2.pid} (\rho_{T2}(Catalog))))$



$\{ \langle c1.sid, c2.sid \rangle \mid c1 \in Catalog \wedge c2 \in Catalog \wedge c1.pid = c2.pid \wedge c1.cost > c2.cost \}$

$\{ \langle sid1, sid2 \rangle \mid \langle sid1, pid, cost1 \rangle \in Catalog \wedge \langle sid2, pid, cost2 \rangle \in Catalog \wedge cost1 > cost2 \}$

5.

$$\pi_{T1.pid}((\rho_{T1}(Catalog)) \bowtie_{T1.pid=T2.pid \wedge T1.sid \neq T2.sid} (\rho_{T2}(Catalog)))$$

$$\{ \langle c.pid \rangle \mid c \in Catalog \wedge \exists c2 (c2 \in Catalog \wedge c.pid = c2.pid \wedge c.sid \neq c2.sid) \}$$

$$\{ \langle pid \rangle \mid \langle sid1, pid, - \rangle \in Catalog \wedge \langle sid2, pid, - \rangle \in Catalog \wedge sid1 \neq sid2 \}$$

5. Functional dependencies

| FD | OK or violated? |
|--------------------|----------------------|
| $A \rightarrow C$ | violated: tuples 3,4 |
| $B \rightarrow A$ | OK |
| $C \rightarrow A$ | violated: tuples 1,3 |
| $A \rightarrow B$ | violated: tuples 1,2 |
| $B \rightarrow C$ | violated: tuples 3,4 |
| $BC \rightarrow A$ | OK |
| $AC \rightarrow B$ | OK |