# Data Modeling and Databases: Homework 3

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## 1 Task 1

I translated the ER model to following relation data model:

- Treatment (PID, code dosage, indications)
- Medicine (code, price)
- Patient (PID, name, address, code)
- Doctor (EID, speciality, E_address, salary, E_name)
- Trainee (EID, speciality, E_address, salary, E_name)
- Permanent (EID, speciality, E_address, salary, E_name)
- Visiting (EID, speciality, E_address, salary, E_name)
- Rooms (Room_id, period)
- Nurse (EID, shift, E_address, salary, E_name, Room_id)
- Employee (EID, E_address, salary, E_name)
- Receptionist (EID, E_address, salary, E_name)
- Record (RecordN, appointment, Patient_id, EID)
- attends ( PID, EID)
- assigned (PID, Room_id)

## 2 Task 2

a) $(\sigma_{Room\_id=107}(Nurse) \rtimes Employee) \cup ((\sigma_{Room\_id=107}(assigned) \rtimes attends) \rtimes Employee)$

b) $Nurse - ((((\sigma_{E\_name="Dr.Alex"}(Doctor)) \rtimes attends) \rtimes assigned) \rtimes Nurse)$

c) $(Employee \bowtie_{salary > docs.salary} \rho_{docs}(Employee \ltimes Doctors)) \rtimes Employee$
Second variant:
$\sigma_{salary > min(Doctor.salary)}(Employee)$

d) $assigned \rtimes Rooms$

## 3 Task 3

a) $\sigma_{E2.salary=max(E2.salary)} \rho_{E2}(\sigma_{E1.salary<max(E1.salary)}$
$\rho_{E1}(\sigma_{Employees.salary<max(Employees.salary)}(Employees)))$
Result: {(3, Alex, $60,000 )}

b) $((\sigma_{range \leq distance}(\pi_{distance}(\sigma_{flight\#=100}(Flights)) \times Aircraft) \rtimes Certified) \rtimes Employees)$
Result: {(3, Alex, $60,000 ),(4,Sam,$40,000)}

c) $((((\sigma_{salary>70000}(Employees)) \rtimes Certified) \rtimes Aircraft) \rtimes_{distance<=range} Flights) \rtimes Flights$
Result: {(112, Moscow, Kazan, 600), (111, Kazan, Moscow, 600), (300, Kazan, St. Petersburg, 1000)}

## 4 Task 4

$0 \leq |R \bowtie S| \leq m * n$
Minimal number of tuples in $|R \bowtie S|$ is 0. It will be if R and S have several common domains, but there are not have intersected tuples. Maximal number of tuples is m*n. It will be if two relations have common domains which contains single number.

## 5 Task 5

$\pi_N(R - S) \neq \pi_N(R) - \pi_N(S)$.
**Example**:
R={(1,1), (2,2), (3,3)}, where R(N,A).
S={(1,1), (2,3), (4,3)}, where S(N,A).
Then $\pi_N(R - S) = \pi_N(\{(2, 2), (3, 3)\}) = \{(2), (3)\}$,
but $\pi_N(R) - \pi_N(S) = \{(1), (2), (3)\} - \{(1), (2), (4)\} = \{(3)\}$.

# 6 Task 6

a) In this exercise we can see amount of domain: $R \bowtie S$ (A, B, C, D) have 4 domains, but $(\sigma_{R.C=S.C}(R \times S)(R.A, R.B, R.C, S.C, S.D))$ have 5 domains. So these relations are not equivalent.

b) For solving this problem I modelled all actions on relations (include tuples): join and projection. Let $R = \{(a_1, b_1, c_1), ..., (a_n, b_n, c_n)\}, where|R| = n; S = \{(c\prime_1, d_1), ..., (c\prime_n, d_n)\}, where|S| = m.$
We know that R and S have one intersection by domain "C". And "C" will define $R \bowtie S$. So we can divide all domain "C" in R and in S on two part: $c_i$ with pair in S.C domain and without. And so we can change order of tuples in relations using following condition: $c_i = c\prime_i, where1 \leq i \leq k \leq min(m, n)$. So if $i \leq k$ than $c_i$ have pair, if $i \geq k$ than have not pair. It's main think. Now we will model all actions using our manipulation:

- $R \bowtie S = \{(a_i, b_i, c_i, d_i)\}, where1 \leq i \leq k$
  $\pi_c(R \bowtie S) = \{(c_i)\}, where1 \leq i \leq k$
- $\pi_c(R) = \{(c_i)\}, where1 \leq i \leq n$
  $\pi_c(S) = \{(c\prime_j)\}, where1 \leq j \leq m$
  $\pi_c(R) \bowtie \pi_c(S) = \{c_i)\}, where1 \leq i \leq k$
- In the end, we have following:
  $\pi_c(R \bowtie S) = \{(c_i)\} = \pi_c(R) \bowtie \pi_c(S)$