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1. (6.16) Specify the following queries on the COMPANY relational database schema shown in Figure 5.5, using relational operators discussed in this chapter. Also show the result of each query as it would apply to the database state in Figure 3.6

a. Retrieve the names of all employees in department 5 who work more than 10 hours per week on the ProductX project

1. dept5_emp $\leftarrow \sigma_{dno = '5'}(employee) \bowtie_{ssn = essn} \sigma_{hours > 10.0}(works\_on)$
2. projectX $\leftarrow \sigma_{pname = "ProductX"}(project) \bowtie_{pnumber = pno} (dept5\_emp)$
3. answer $\leftarrow \pi_{fname, minit, lname}(ProjectX)$

Explanations

1. dept5_emp is a temporary variable that selects employees that are in department number “5” and equijoins this with the table selected tuples with hours greater than 10 hours in table “works_on” based on equivalent ssn in “employee” and essn in “works_on”
2. projectX is a temporary variable that selects the tuple that has the project name “ProductX” and equijoins this with the previous stored temporary variable dept5_emp
3. the final answer is found by projecting the first name, middle initial, and last name (fname, minit, lname) from the temporary variable ProjectX

fname	minit	lname
John	B	Smith
Joyce	A	English

b. List the names of all employees who have a dependent with the same first name as themselves.

1. employee_deps $\leftarrow$ employee $\bowtie_{ssn = essn \text{ and } fname = dependent\_name}$ dependent
2. answer $\leftarrow \pi_{fname, minit, lname}$ (employee_deps)

Explanations

1. the temporary variable “employee_deps” to store the equijoin between “employee” and “dependent” tables where the parameters equate between ssn with essn, and first name with dependent name.
2. the answer is found when projecting the first name, middle initial, and last name from the previous temporary variable “employee_deps”

answer $\leftarrow \pi_{fname, minit, lname}$ (employee $*_{fname, dependent\_name \text{ and } ssn, essn}$ dependent)

fname	minit	lname
NULL	NULL	NULL

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f. Retrieve the names of all employees who do not work on every project.

answer ← $\pi_{fname,\ minit,\ lname}$ (employee - (employee $*_{ssn,\ essn}$ π_{essn}(works_on)))

Explanation

First the employees that work on projects are found by naturally joining ssn = essn of “employee” with the projection of just the essn attribute of “works_on”. This is then subtracted by the table “employee” to find the employees that do not work, and this is made possible since we limited the dimensions of previous . To retrieve the name, the first name, middle initial, and last name are projected from that result.

fname	minit	lname
James	E	Borg

h. Retrieve the average salary of all female employees

answer ← $_{sex\ =\ 'female'}\mathcal{F}_{AVERAGE\ salary}$ (employee)

answer = 31000

Explanation:

the answer can be found by using the average function over the attribute salary of the table “employee” all while chosing only tuples with the sex is female

2. (6.17) Consider the AIRLINE relational database schema shown in Figure 3.8, which was described in Exercise 3.12. Specify the following queries in relational algebra.

a. For each flight, list the flight number, the departure airport for the first leg of the flight, and the arrival airport for the last leg of the flight.

1. first_leg ← $\pi_{flight\_number,\ departure\_airport\_code}(_{flight\_number}\mathcal{F}_{MINIMUM\ leg\_number}$(flight_leg))
2. last_leg ← $\pi_{flight\_number,\ arrival\_airport\_code}(_{flight\_number}\mathcal{F}_{MAXIMUM\ leg\_number}$(flight_leg))
3. answer ← first_leg $*_{flight\_number,\ flight\_number}$ last_leg

Explanation

1. first_leg temporary variable is given by the minimum function over attribute ‘leg_number’ of table ‘flight_leg’ given the flight number then projected with the flight number and departure airport code
2. last_leg temporary variable is given by maximum function over attribute ‘leg_number’ of table ‘flight_leg’ given the flight number then projected with the flight number and arrival airport code
3. the answer is then given by naturally joining the two temp. variables through their flight numbers

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b. List the flight numbers and weekdays of all flights of flight legs that depart from Houston Intercontinental Airport (airport code 'IAH') and arrive in Los Angeles International Airport (airport code 'LAX')

answer ← $\pi_{\text{flight\_number, weekdays}}(\sigma_{\text{departure\_airport\_code = 'IAH', arrival\_airport\_code = "LAX"}}(\text{flight\_leg}) *_{\text{flight\_number, flight\_number}} (\text{flight}))$

Explanation:

By selecting the flights with only departure airport code with 'IAH', and arrival airport code 'LAX', from table 'flight leg'. This can be naturally joined with the table "flight", and the answer desired can be projected with attributes flight number and weekdays.

c. List the flight number, departure airport code, scheduled departure time, arrival airport code, scheduled arrival time, and weekdays of all flights or flight legs that depart from some airport in the city of Houston and arrive at some airport in the city of Los Angeles.

1. Hou_dep ← flight_leg $*_{\text{depature\_airport\_code, airport\_code}}$ ($\sigma_{\text{city = 'Houston'}}$(airport))
2. LA_arr ← flight_leg $*_{\text{arrival\_airport\_code, airport\_code}}$ ($\sigma_{\text{city = 'Los Angeles'}}$(airport))
3. HouLA_flights ← flight $*_{\text{flight\_number, flight\_number}}$(Hou_dep $*_{\text{arrival\_airport\_code, arrival\_airport\_code}}$ LA_arr)
4. answer ← $\pi_{\text{flight\_number, departure\_airport\_code, scheduled\_departure\_time, arrival\_airport\_code, scheduled\_arrival\_time, weekdays}}$(HouLA_flights)

Explanation:

1. Hou_dep is set to table naturally joined by the attribute 'departure_airport_code' of table 'flight_leg' with the attribute 'airport_code' of table 'table airport' after selecting the rows where the city is Houston
2. LA_arr does something similar to 1. but with arrival airport codes of flight legs and the selection where city is Los Angeles from table 'airport'
3. HouLA_flights are the flights between Houston and LA that are given by first naturally joining the two previous temp. variables through their attribute arrival airport code, and then naturally joining this with flight through their attribute flight number
4. The answer is found by projecting all the necessary attribute columns that the question requested, being: flight number, departure airport code, scheduled departure time, arrival airport code, scheduled arrival time of 'HouLA_flight'

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EMPLOYEE

Fname	Minit	Lname	Ssn	Bdate	Address	Sex	Salary	Super_ssn	Dno
John	B	Smith	123456789	1965-01-09	731 Fondren, Houston, TX	M	30000	333445555	5
Franklin	T	Wong	333445555	1955-12-08	638 Voss, Houston, TX	M	40000	888665555	5
Alicia	J	Zelaya	999887777	1968-01-19	3321 Castle, Spring, TX	F	25000	987654321	4
Jennifer	S	Wallace	987654321	1941-06-20	291 Berry, Bellaire, TX	F	43000	888665555	4
Ramesh	K	Narayan	666884444	1962-09-15	975 Fire Oak, Humble, TX	M	38000	333445555	5
Joyce	A	English	453453453	1972-07-31	5631 Rice, Houston, TX	F	25000	333445555	5
Ahmad	V	Jabbar	987987987	1969-03-29	980 Dallas, Houston, TX	M	25000	987654321	4
James	E	Borg	888665555	1937-11-10	450 Stone, Houston, TX	M	55000	NULL	1

DEPARTMENT

Dname	Dnumber	Mgr_ssn	Mgr_start_date
Research	5	333445555	1988-05-22
Administration	4	987654321	1995-01-01
Headquarters	1	888665555	1981-06-19

DEPT_LOCATIONS

Dnumber	Dlocation
1	Houston
4	Stafford
5	Bellaire
5	Sugarland
5	Houston

WORKS_ON

Essn	Pno	Hours
123456789	1	32.5
123456789	2	7.5
666884444	3	40.0
453453453	1	20.0
453453453	2	20.0
333445555	2	10.0
333445555	3	10.0
333445555	10	10.0
333445555	20	10.0
999887777	30	30.0
999887777	10	10.0
987987987	10	35.0
987987987	30	5.0
987654321	30	20.0
987654321	20	15.0
888665555	20	NULL

PROJECT

Pname	Pnumber	Plocation	Dnum
ProductX	1	Bellaire	5
ProductY	2	Sugarland	5
ProductZ	3	Houston	5
Computerization	10	Stafford	4
Reorganization	20	Houston	1
Newbenefits	30	Stafford	4

DEPENDENT

Essn	Dependent_name	Sex	Bdate	Relationship
333445555	Alice	F	1986-04-05	Daughter
333445555	Theodore	M	1983-10-25	Son
333445555	Joy	F	1958-05-03	Spouse
987654321	Abner	M	1942-02-28	Spouse
123456789	Michael	M	1988-01-04	Son
123456789	Alice	F	1988-12-30	Daughter
123456789	Elizabeth	F	1967-05-05	Spouse

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AIRPORT

Airport_code	Name	City	State

FLIGHT

Flight_number	Airline	Weekdays

FLIGHT_LEG

Flight_number	Leg_number	Departure_airport_code	Scheduled_departure_time
		Arrival_airport_code	Scheduled_arrival_time

LEG_INSTANCE

Flight_number	Leg_number	Date	Number_of_available_seats	Airplane_id
		Departure_airport_code	Departure_time	Arrival_airport_code	Arrival_time

FARE

Flight_number	Fare_code	Amount	Restrictions

AIRPLANE_TYPE

Airplane_type_name	Max_seats	Company

CAN_LAND

Airplane_type_name	Airport_code

AIRPLANE

Airplane_id	Total_number_of_seats	Airplane_type

SEAT_RESERVATION

Flight_number	Leg_number	Date	Seat_number	Customer_name	Customer_phone

Figure 3.8
The AIRLINE relational database schema.