Homework 2 (60/75 points)

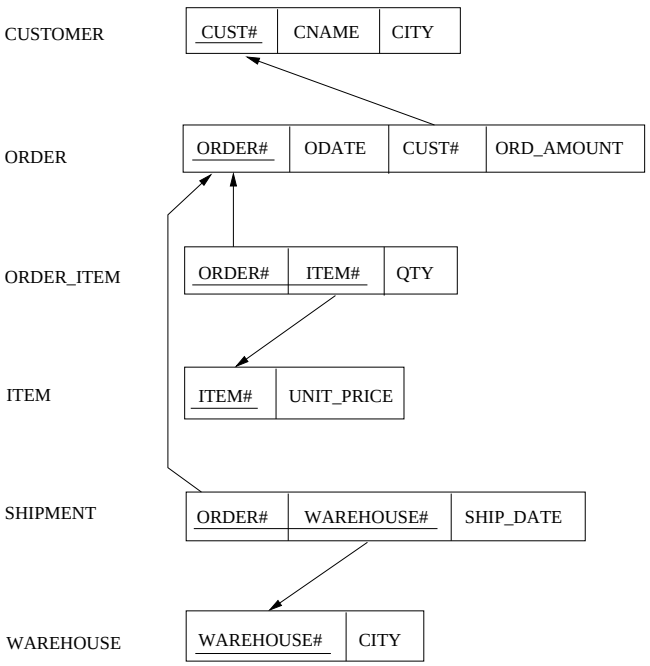
Exercise 5.11 (10 points)

Suppose that each of the following update operations is applied directly to the database state shown in Figure 5.6. Discuss all integrity constraints violated by each operation, if any.

- (a) Insert <'Robert', 'F', 'Scott', '943775543', '1952-06-21', '2365 Newcastle Rd, Bellaire, TX', M, 58000, '888665555', 1> into EMPLOYEE.
  - No violation.
- (b) Insert <'ProductA', 4, 'Bellaire', 2> into PROJECT.
  - Referential integrity constraint violation on DNUM = 2. No such department exists.
- (c) Insert <'Production', 4, '943775543', '1998-10-01'> into DEPARTMENT.
  - Key contraint violation on DNUMBER = 4. DNUMBER = 4 already exists.
  - Referential integrity constraint violation on MGRSSN = '943775543'. No such employee exists.
- (d) Innsert <'677678989', NULL, '40.0'> into WORKS_ON.
  - Referential integrity constraint violation on ESSN= '677678989'. No such employee exists.
  - Entity integrity constraint violation on PNO = NULL.
- (e) Insert <'453453453', 'John', 'M', '1970-12-12', 'spouse'> into DEPENDENT.
  - No violation.
- (f) Delete the WORKS_ON tuples with ESSN = '333445555'.
  - No violation.
- (g) Delete the EMPLOYEE tuple with SSN = '987654321'.
  - Referential integrity constraint violations. Foreign keys EMPLOYEE(SUPERSSN), DEPARMENT(MGRSSN), WORKS_ON(ESSN), and DEPENDENT(ESSN) referred to the deleting tuple.

- (h) Delete the PROJECT tuple with PNAME = 'ProductX'.
  - Referential integrity constraint violations. Foreign keys WORKS_ON(PNO) referred to the deleting tuple.
- (i) Modify the MGRSSN and MGRSTARTDATE of the DEPARTMENT tuple with DNUMBER = 5 to '123456789' and '1999-10-01', respectively.
  - No violation.
- (j) Modify the SUPERSSN attribute of the EMPLOYEE tuple with SSN = '999887777' to '943775543'.
  - Referential integrity constraint violation on SUPERSSN= '943775543'. No such employee exists.
- (k) Modify the HOURS attribute of the WORKS_ON tuple with ESSN = '999887777' and PNO = 10 to '5.0'.
  - No violation.

Exercise 5.14 **(10 points)**



Exercise 6.16 (15/30 points)

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

  $E\_D5 \leftarrow \sigma_{DNO=5}(EMPLOYEE)$

  $PJ\_PRODUCTX \leftarrow \sigma_{PNAME='ProductX'}(PROJECT)$

  $E\_PJ\_MORE\_10 \leftarrow \sigma_{HOURS>10}(WORKS\_ON)$

  $PJ\_W \leftarrow PJ\_PRODUCTX \bowtie_{PNUMBER=PNO} E\_PJ\_MORE\_10$

  $RESULT \leftarrow \pi_{FNAME,MINIT,LNAME}(E\_D5 \bowtie_{SSN=ESSN} PJ\_W)$

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

  $E\_D \leftarrow EMPLOYEE \bowtie_{SSN=ESSN} DEPENDENT$

  $SAME\_NAME \leftarrow \sigma_{FNAME=DEPENDENT\_NAME}(E\_D)$

  $RESULT \leftarrow \pi_{FNAME,MINIT,LNAME}(SAME\_NAME)$

- (c) Find the names of all employees who are directly supervised by 'Franklin Wong'.

  $F\_W \leftarrow \pi_{SSN}(\sigma_{FNAME='Franklin' \ AND \ LNAME='Wong'}(EMPLOYEE))$

  $E\_SUPERVISED\_BY\_F\_W \leftarrow EMPLOYEE \bowtie_{SUPERSSN=SSN} F\_W$

  $RESULT \leftarrow \pi_{FNAME,MINIT,LNAME}(E\_SUPERVISED\_BY\_F\_W)$

- (d) For each project, list the project name and the total hours per week (by all employees) spent on that project.

  $T\_HOURS\_PER\_PNO \leftarrow {}_{PNO}\Im_{SUM \ HOURS}(WORKS\_ON)$

  $T\_HOURS\_PER\_PNAME \leftarrow T\_HOURS\_PER\_PNO \bowtie_{PNO=PNUMBER} PROJECT$

  $RESULT \leftarrow \pi_{PNAME,SUM\_HOURS}(T\_HOURS\_PER\_PNAME)$

- (e) Retrieve the names of all employees who work on every projects.

  $PJ\_PNO(PNO) \leftarrow \pi_{PNUMBER}(PROJECT)$

  $WORKS\_ON\_ESSN\_PNO \leftarrow \pi_{ESSN,PNO}(WORKS\_ON)$

  $E\_WORKON\_ALL\_PJ \leftarrow WORKS\_ON\_ESSN\_PNO \div PJ\_PNO$

  $ENAME\_WORKON\_ALL\_PJ \leftarrow EMPLOYEE \bowtie_{SSN=ESSN} E\_WORKON\_ALL\_PJ$

  $RESULT \leftarrow \pi_{FNAME,MINIT,LNAME}(ENAME\_WORKON\_ALL\_PJ)$

- (f) Retrieve the names of all employees who do not work on any project.

  $ALL\_E\_SSN \leftarrow \pi_{SSN}(EMPLOYEE)$

$E\_SSN\_WORKON\_PJ \leftarrow \pi_{ESSN}(WORKS\_ON)$

$E\_SSN\_NOT\_WORKON\_PJ \leftarrow ALL\_E\_SSN - E\_SSN\_WORKON\_PJ$

$ENAME\_NOT\_WORKON\_PJ \leftarrow EMPLOYEE * E\_SSN\_NOT\_WORKON\_PJ$

$RESULT \leftarrow \pi_{FNAME,MINIT,LNAME}(ENAME\_NOT\_WORKON\_PJ)$

- (g) For each department, retrieve the department name and the average salary of all employees working in that department.

  $DNO\_AV\_SALARY \leftarrow {}_{DNO}\Im_{AVERAGE\ SALARY}(EMPLOYEE)$

  $DNAME\_AV\_SALARY \leftarrow DEPARTMENT \bowtie_{DNUMBER=DNO} DNO\_AV\_SALARY$

  $RESULT \leftarrow \pi_{DNAME,AVERAGE\_SALARY}(DNAME\_AV\_SALARY)$

- (h) Retrieve the average salary of all female employees.

  $F\_EMPLOYEE \leftarrow \sigma_{SEX='F'}(EMPLOYEE)$

  $RESULT \leftarrow \Im_{AVERAGE\ SALARY}(F\_EMPLOYEE)$

- (i) Find the names and addresses of all employees who work on at least one project located in Houston but whose department has no location in Houston.

  $PJ\_IN\_H \leftarrow \sigma_{PLOCATION='Houston'}(PROJECT)$

  $E\_PJ\_IN\_H \leftarrow \pi_{ESSN}(PJ\_IN\_H \bowtie_{PNUMBER=PNO} WORKS\_ON)$

  $D\_IN\_H \leftarrow \sigma_{DLOCATION='Houston'}(DEPT\_LOCATIONS)$

  $E\_D\_IN\_H \leftarrow \pi_{SSN}(D\_IN\_H \bowtie_{DNUMBER=DNO} EMPLOYEE)$

  $E\_PJH\_NOT\_DH \leftarrow E\_PJ\_IN\_H - E\_D\_IN\_H$

  $ENAME\_PJH\_NOT\_DH \leftarrow EMPLOYEE \bowtie_{SSN=ESSN} E\_PJH\_NOT\_DH$

  $RESULT \leftarrow \pi_{FNAME,MINIT,LNAME,ADDRESS}(ENAME\_PJH\_NOT\_DH)$

- (j) List the last names of all department managers who have no dependents.

  $ALL\_M \leftarrow \pi_{MGRSSN}(DEPARTMENT)$

  $E\_WITH\_DEP \leftarrow \pi_{ESSN}(DEPENDENT)$

  $M\_WITHOUT\_DEP \leftarrow ALL\_M - E\_WITH\_DEP$

  $MNAME\_WITHOUT\_DEP \leftarrow EMPLOYEE \bowtie_{SSN=MGRSSN} M\_WITHOUT\_DEP$

  $RESULT \leftarrow \pi_{LNAME}(MNAME\_WITHOUT\_DEP)$

Exercise 6.22 (10 points)

- (a) $T1 \bowtie_{T1.P=T2.A} T2$

P	Q	R	A	B	C
10	a	5	10	b	6
10	a	5	10	b	5
25	a	6	25	c	3

- (b) $T1 \bowtie_{T1.Q=T2.B} T2$

P	Q	R	A	B	C
15	b	8	10	b	6
15	b	8	10	b	5

- (c) $T1 \sqsupset\!\bowtie_{T1.P=T2.A} T2$

P	Q	R	A	B	C
10	a	5	10	b	6
10	a	5	10	b	5
25	a	6	25	c	3
15	b	8	null	null	null

- (d) $T1 \bowtie\!\sqsubset_{T1.Q=T2.B} T2$

P	Q	R	A	B	C
15	b	8	10	b	6
15	b	8	10	b	5
null	null	null	25	c	3

- (e) $T1 \cup T2$

P	Q	R
10	a	5
10	b	6
10	b	5
15	b	8
25	a	6
25	c	3

- (f) $T1 \bowtie_{(T1.P=T2.A \ AND \ T1.R=T2.C)} T2$

P	Q	R	A	B	C
10	a	5	10	b	5

ER-to-Relational Mapping for University Database (15 points)