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DATABASE DESIGN I - 1DL300

Assignment 2 - Database Design and ER Modeling

1 Database Design and ER Modeling

The overall purpose of the lab is to practice the process of modeling and designing a relational database given a specific scenario. The assignment involves extending a given entity-relationship (ER) diagram, and then translating the extended diagram to the relational model. The student should become familiar with how to create tables in SQL, define primary and foreign keys, and insert data into tables and update data in tables.

After the assignment, the student should be able to model real world scenarios in terms of enhanced entity-relationship (EER) models and to translate an EER diagram into a corresponding relational database implementation.

2 Preparation

If needed, install the Mimer system on your PC (not necessary if you run the assignment at the university) and then set up the Jonson Brothers database. Instructions for installing Mimer and scripts for loading the database can be found at the assignment course webpage.

- Elmasri and Navathe [EN10]: Chapter 4, 5 and 7.
- Padron-McCarthy and Risch [PMR05]: Chapter 2, 3, 7, and 9.

There is an supervised introduction to the assignment in your schedule.

3 Assignment

3.1 The scenario - a company database

The Jonson Brothers is a retail company with department stores in many major US cities. The company has a large number of employees and sells a varied line of products. To manage all information about the company structure and products, a database system is used. The company consists of a number of stores that contain a number of departments. The company has a number of employees, who (among other things) sell items at the different stores. Sales are registered in the sale and debit tables. The sale and debit tables may be a bit tricky to understand. You can view a row in the debit table as representing the complete receipt you get when you pay for your items, while a row in the sale table represents a row on such a receipt.

The company has contracts with various suppliers, who supply items for sale and also parts for the companys computer equipment. Deliveries of computer parts are registered in the supply table. The current state of the company database can be seen in the ER diagram given in Appendix A and the table definitions and contents in the Appendices B and C.

The business is expanding and the database is continuously being extended with new information. The management of Jonson Brothers has hired you to help them to extend their database. The work requires extensions to support a bonus system where managers can be given an extra bonus (e.g. if their departments have met their sale predictions) added to their salary. The management also wants to tie up customers to shop more by creating a credit card that users can use when paying for items that they buy.

3.2 Exercises

IMPORTANT NOTICE: Please be aware that Assignment 3 will be based on the results of these exercises. Putting effort into good solutions and to understand them is therefore highly recommended.

1. Start by analyzing the ER diagram in Appendix A, and the relational database in Appendices B and C. Based on the structure of the relational database denote on the diagram cardinality ratios of the relationships, such as one-to-one, one-to-many, and many-to-many. Also add participation constraints, such as partial or total participation.

2. Extend the ER diagram with an entity type `manager` that is a sub-class of employee. A manager is an employee who is head of a department, or manager of other employees, or both. Add support for a manager bonus that is added to the salary, by giving the manager entity a bonus attribute. Draw your extensions to the ER diagram in Appendix A, translate the extension to the relational model, and implement it in the company database.

3. Once you have changed the schema, change also the data, so that all managers are managers! That is, if you have made a manager table, you should insert data in it. Since manager data already exists in the database, it is desirable that you select it instead of entering it row by row. You also have to change the database implementation to ensure that only managers manage employees and departments.

4. All departments showed good sales figures last year! Give all current department managers 10000 in bonus. Note that not all managers are department managers.

5. In the existing database, your customers can buy things and pay for them, as reflected by the `sale` and `debit` tables. There is also support for membership cards (the `account` attribute). Now, you want to extend the membership card system, with possible credit. The customers will have accounts, where they can deposit and withdraw money, and pay for the purchases. Add the following:

   - Information about customers such as name, street address, city, and state must be stored. Notice that the database already contains some city information and avoid redundancies!
   - Information about accounts such as account number, balance, and allowed credit.
   - Information about account deposits and withdrawals such as transaction number, account number, amount, date, and the time of deposit or withdrawal, and the employee responsible for the transaction (that is, the employee that registers the transaction, not the customer that owns the account). Replace the entity type `debit` by a more general entity type, `transaction`. This entity type should represent not only sales transactions, but also deposits and withdrawals. You may want to drop the table `debit`, and create a new table `transaction` for this new information. Note that table `debit` contains data, which should not be lost. You will need aggregated functions to fill new "amount" column for the existing transactions.
   - Customers and accounts should be defined with customer and account numbers (integers) that can be automatically generated.

Extend the EER diagram with your new entities, relationships, and attributes. Implement your extensions into your database in Mimer. Ensure that all new relations are in BCNF. Add primary keys and any foreign keys to your table definitions.

Hints:

- Foreign keys are added either when defining a table (after the attribute definitions), or by altering it:

```
ALTER TABLE tablename1
ADD FOREIGN KEY (columnname1, columnname2, ...)
REFERENCES tablename2 (columnname1, columnname2, ...);
```

- Sequences are used to automatically generate unique numbers:

```
CREATE UNIQUE SEQUENCE seqname
INITIAL_VALUE = init_value INCREMENT = increment;
```

  The generated sequence of numbers can be used as a default value for a column in a table definition:

```
 DEFAULT NEXT_VALUE OF seqname
```

For further details, you are referred to the Mimer SQL Language Reference for details [M10]. Also, you can take a look in the script files that you loaded the original database from.

4 Examination

You should hand in an assignment report that include the following:

1. Your new EER diagram. You can extend and modify (possibly by hand) the ER diagram given in Appendix A.
2. SQL commands modifying the database schema and data: table definitions including primary and foreign key definitions, inserts, and updates. Include the replies from the database server when the commands are run;
3. Motivation why your relations are in BCNF by specifying all functional dependencies.

Note that you should hand in these solutions in one assignment report per group.

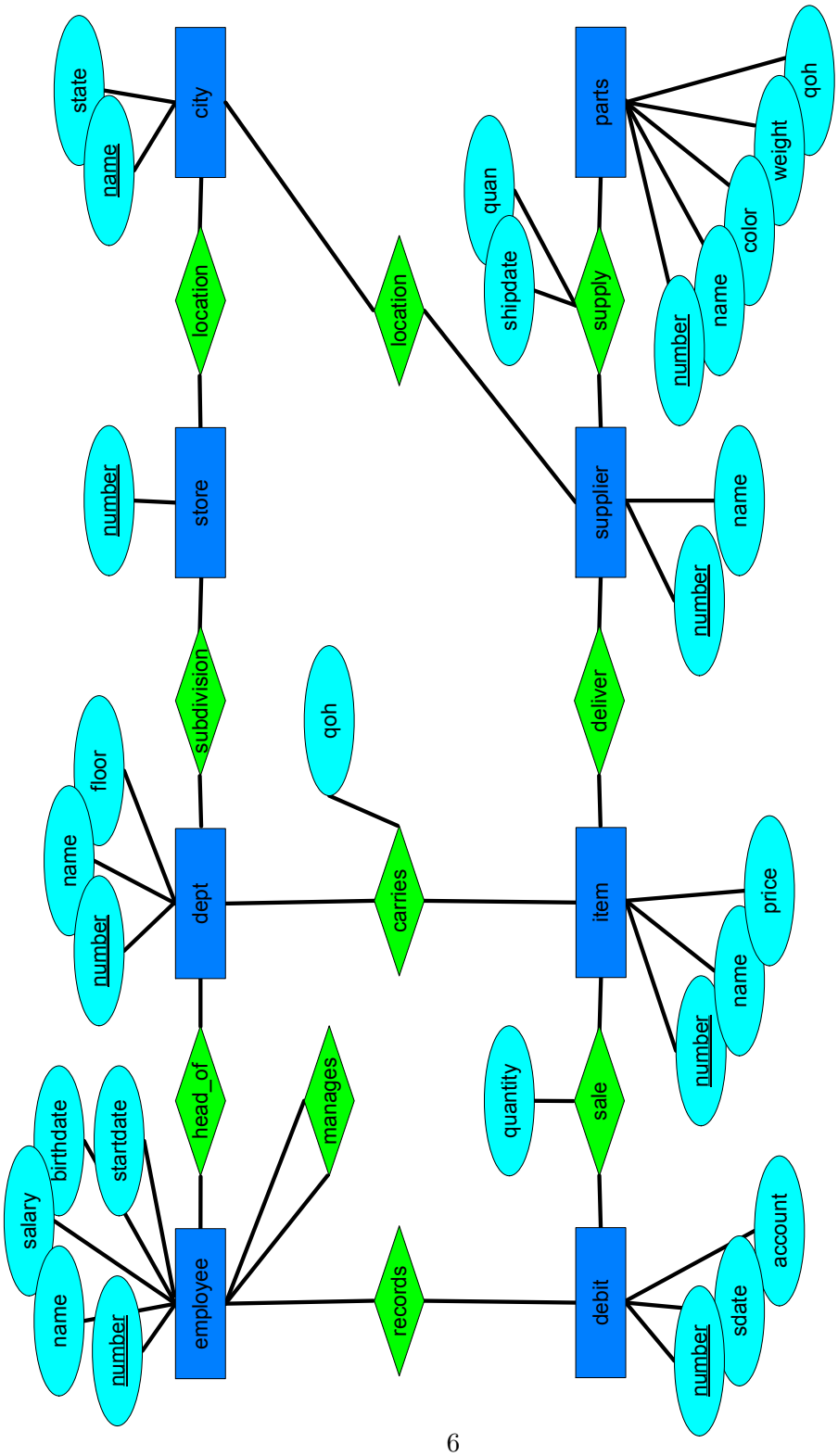
References

[EN10] Elmasri, R. and Navathe, S. B.: Fundamentals of Databases, 6th Edition, Addison-Wesley, 2010 (available e.g. at Akademibokhandeln).

[PMR05] Padron-McCarthy, T. and Risch, T.: Databasteknik, Studentlitteratur, 2005 (available e.g. at Akademibokhandeln).

[M10] Mimer documentation, Version 9.2 (html) (include User's Manual, Reference Manual and Programmer's Manual), `http://developer.mimer.com/documentation/html_92/Mimer_SQL_Engine_DocSet/Mimer_SQL_Engine.htm`.

Appendix A: Entity-relationship diagram of the Jonson Brothers company database



Appendix B: The DDL statements creating the Jonson Brothers company database schema

The schema for the existing company database is given below:

```
CREATE TABLE employee
(number INTEGER CONSTRAINT pk_employee PRIMARY KEY,
 name VARCHAR(20),
 salary INTEGER,
 manager INTEGER,
 birthyear INTEGER,
 startyear INTEGER);

CREATE TABLE dept
(number INTEGER CONSTRAINT pk_dept PRIMARY KEY,
 name VARCHAR(20),
 store INTEGER NOT NULL,
 floor INTEGER,
 manager INTEGER);

CREATE TABLE item
        (number INTEGER CONSTRAINT pk_item PRIMARY KEY,
         name VARCHAR(20),
         price INTEGER,
         supplier INTEGER NOT NULL);

CREATE TABLE carries
(item INTEGER NOT NULL,
 dept INTEGER NOT NULL,
 qoh INTEGER CONSTRAINT ck_item_qoh CHECK (qoh >= 0),
 CONSTRAINT pk_carries PRIMARY KEY (item, dept));

CREATE TABLE parts
(number INTEGER CONSTRAINT pk_parts PRIMARY KEY,
 name VARCHAR(20),
 color VARCHAR(8),
 weight INTEGER,
 qoh INTEGER);

CREATE TABLE supply
(supplier INTEGER NOT NULL,
 part INTEGER NOT NULL,
 shipdate DATE NOT NULL,
 quan INTEGER,
 CONSTRAINT pk_supply PRIMARY KEY (supplier, part, shipdate));

CREATE TABLE sale
(debit INTEGER NOT NULL,
 item INTEGER NOT NULL,
 quantity INTEGER,
 CONSTRAINT pk_sale PRIMARY KEY (debit, item));

CREATE TABLE debit
(number INTEGER CONSTRAINT pk_debit PRIMARY KEY,
 sdate DATE DEFAULT CURRENT_DATE NOT NULL,
 employee INTEGER NOT NULL,
 account INTEGER);

CREATE TABLE city
(name VARCHAR(15) CONSTRAINT pk_city PRIMARY KEY,
```

```
 state VARCHAR(6));


CREATE TABLE store
(number INTEGER CONSTRAINT pk_store PRIMARY KEY,
 city VARCHAR(15) NOT NULL);

CREATE TABLE supplier
(number INTEGER CONSTRAINT pk_supplier PRIMARY KEY,
 name VARCHAR(20),
 city VARCHAR(15) NOT NULL);

-- Add foreign keys

ALTER TABLE dept
ADD CONSTRAINT fk_dept_store FOREIGN KEY (store) REFERENCES store (number);

ALTER TABLE dept
ADD CONSTRAINT fk_dept_employee FOREIGN KEY (manager) REFERENCES employee (number)
        ON DELETE SET NULL;

ALTER TABLE carries
ADD CONSTRAINT fk_carries_dept FOREIGN KEY (dept) REFERENCES dept (number);

ALTER TABLE item
ADD CONSTRAINT fk_item_supplier FOREIGN KEY (supplier) REFERENCES supplier (number);

ALTER TABLE supply
ADD CONSTRAINT fk_supply_supplier FOREIGN KEY (supplier) REFERENCES supplier (number);

ALTER TABLE supply
ADD CONSTRAINT fk_supply_parts FOREIGN KEY (part) REFERENCES parts (number);

ALTER TABLE sale
ADD CONSTRAINT fk_sale_item FOREIGN KEY (item) REFERENCES item (number);

ALTER TABLE sale
ADD CONSTRAINT fk_sale_debit FOREIGN KEY (debit) REFERENCES debit(number);
-- implies that a debit/transaction must be created before a sale record.

ALTER TABLE debit
ADD CONSTRAINT fk_debit_employee FOREIGN KEY (employee) REFERENCES employee(number);

ALTER TABLE store
ADD CONSTRAINT fk_store_city FOREIGN KEY (city) REFERENCES city (name);

ALTER TABLE supplier
ADD CONSTRAINT fk_supplier_city FOREIGN KEY (city) REFERENCES city (name);

-- Create the view that has to be modified in Assignment 3, question 17

CREATE VIEW sale_supply(supplier, item, quantity) as
SELECT supplier.name, item.name, sale.quantity
FROM supplier, item, sale
WHERE supplier.number = item.supplier AND
sale.item = item.number;
```

Appendix C: The contents of the existing company Jonson Brothers database

The tables of the existing company database are given below:

```
SELECT * FROM employee;
```

NUMBER	NAME	SALARY	MANAGER	BIRTHYEAR	STARTYEAR
10	Ross, Stanley	15908	199	1927	1945
11	Ross, Stuart	12067	-	1931	1932
13	Edwards, Peter	9000	199	1928	1958
26	Thompson, Bob	13000	199	1930	1970
32	Smythe, Carol	9050	199	1929	1967
33	Hayes, Evelyn	10100	199	1931	1963
35	Evans, Michael	5000	32	1952	1974
37	Raveen, Lemont	11985	26	1950	1974
55	James, Mary	12000	199	1920	1969
98	Williams, Judy	9000	199	1935	1969
129	Thomas, Tom	10000	199	1941	1962
157	Jones, Tim	12000	199	1940	1960
199	Bullock, J.D.	27000	-	1920	1920
215	Collins, Joanne	7000	10	1950	1971
430	Brunet, Paul C.	17674	129	1938	1959
843	Schmidt, Herman	11204	26	1936	1956
994	Iwano, Masahiro	15641	129	1944	1970
1110	Smith, Paul	6000	33	1952	1973
1330	Onstad, Richard	8779	13	1952	1971
1523	Zugnoni, Arthur A.	19868	129	1928	1949
1639	Choy, Wanda	11160	55	1947	1970
2398	Wallace, Maggie J.	7880	26	1940	1959
4901	Bailey, Chas M.	8377	32	1956	1975
5119	Bono, Sonny	13621	55	1939	1963
5219	Schwarz, Jason B.	13374	33	1944	1959

25 rows found

```
SELECT * FROM dept;
```

NUMBER	NAME	STORE	FLOOR	MANAGER
1	Bargain	5	0	37
10	Candy	5	1	13
14	Jewelry	8	1	33
19	Furniture	7	4	26
20	Major Appliances	7	4	26
26	Linens	7	3	157
28	Women's	8	2	32
34	Stationary	5	1	33
35	Book	5	1	55
43	Children's	8	2	32
47	Junior Miss	7	2	129
49	Toys	8	2	35
58	Men's	7	2	129
60	Sportswear	5	1	10
63	Women's	7	3	32
65	Junior's	7	3	37
70	Women's	5	1	10
73	Children's	5	1	10
99	Giftwrap	5	1	98

```
                19 rows found


SELECT * FROM store;
     NUMBER CITY
========== ===============
          5 San Francisco
          7 Oakland
          8 El Cerrito

                 3 rows found


SELECT * FROM item;
     NUMBER NAME                      PRICE    SUPPLIER
========== ==================== ========== ==========
         11 Wash Cloth                 75         213
         19 Bellbottoms               450          33
         21 ABC Blocks                198         125
         23 1 lb Box                  215          42
         25 2 lb Box, Mix             450          42
         26 Earrings                 1000         199
         43 Maze                      325          89
         52 Jacket                   3295          15
        101 Slacks                   1600          15
        106 Clock Book                198         125
        107 The 'Feel' Book           225          89
        115 Gold Ring                4995         199
        118 Towels, Bath              250         213
        119 Squeeze Ball              250          89
        120 Twin Sheet                800         213
        121 Queen Sheet              1375         213
        127 Ski Jumpsuit             4350          15
        165 Jean                      825          33
        258 Shirt                     650          33
        301 Boy's Jean Suit          1250          33

                20 rows found


SELECT * FROM carries;
       ITEM        DEPT         QOH
========== ========== ==========
          1         14        220
         11          1        575
         19         43        600
         21          1        405
         21         49        120
         23         10        100
         25         10         75
         26         14         20
         43         49        200
         52         60        300
        101         63        325
        101         28        125
        101         70        225
        106         49        150
        106          1        175
        107         35        225
        115         14         10
        118         26       1000
        119         49        400
```

```
       120          26         750
       121          26         600
       127          65         125
       165          65         500
       258          58        1200
       301          43         500
       301          73         100

                23 rows found


SELECT * FROM parts;
     NUMBER NAME                 COLOR         WEIGHT         QOH
========== ==================== ======== ========== ==========
          1 central processor    pink             10          1
          2 memory               gray             20         32
          3 disk drive           black           685          2
          4 tape drive           black           450          4
          5 tapes                gray              1        250
          6 line printer         yellow          578          3
          7 l-p paper            white            15         95
          8 terminals            blue             19         15
          9 terminal paper       white             2        350
         10 byte-soap            clear             0        143
         11 card reader          gray            327          0
         12 card punch           gray            427          0
         13 paper tape reader    black           107          0
         14 paper tape punch     black           147          0

                14 rows found


SELECT * FROM sale;
TRANSACTION        ITEM    QUANTITY
========== ========== ==========
     100581         118          5
     100581         120          1
     100582          26          1
     100586         106          2
     100586         127          3
     100592         258          1
     100593          23          2
     100594          52          1

                8 rows found


SELECT * FROM debit;
     NUMBER SDATE         EMPLOYEE     ACCOUNT
========== ========== ========== ==========
     100581 1995-01-15         157          -
     100582 1995-01-15        1110   14356540
     100586 1995-01-16          35   14096831
     100592 1995-01-17         129          -
     100593 1995-01-18          13   11652133
     100594 1995-01-18         215   12591815

                6 rows found


SELECT * FROM city;
NAME           STATE
============== ======
Amherst        Mass
```

```
Atlanta         Ga
Boston          Mass
Dallas          Tex
Denver          Colo
El Cerrito      Calif
Hickville       Okla
Los Angeles     Calif
Madison         Wisc
New York        NY
Oakland         Calif
Paxton          Ill
Salt Lake City  Utah
San Diego       Calif
San Francisco   Calif
Seattle         Wash
White Plains    Neb

                17 rows found
```

```
SELECT * FROM supply;
   SUPPLIER        PART SHIPDATE          QUAN
========== ========== ========== ==========
          5          4 1994-11-15          3
          5          4 1995-01-22          6
         20          5 1995-01-10         20
         20          5 1995-01-11         75
         62          3 1994-06-18          3
         67          4 1995-07-01          1
         89          3 1995-07-04       1000
         89          4 1995-07-04       1000
        122          7 1995-02-01        144
        122          7 1995-02-02         48
        122          9 1995-02-01        144
        241          1 1995-06-01          1
        241          2 1995-06-01         32
        241          3 1995-06-01          1
        241          4 1993-12-31          1
        241          8 1995-07-01          1
        241          9 1995-07-01        144
        440          6 1994-10-10          2
        475          1 1993-12-31          1
        475          1 1994-07-01          1
        475          2 1993-12-31         32
        475          2 1994-05-31         32
        475          3 1993-12-31          2
        475          4 1994-05-31          1
        999         10 1996-01-01        144

                25 rows found
```

```
SELECT * FROM supplier;
     NUMBER NAME                 CITY
========== ==================== ===============
          5 Amdahl               San Diego
         15 White Stag           White Plains
         20 Wormley              Hickville
         33 Levi-Strauss         San Francisco
         42 Whitman's            Denver
         62 Data General         Atlanta
         67 Edger                Salt Lake City
         89 Fisher-Price         Boston
        122 White Paper          Seattle
```

```
125 Playskool            Dallas
199 Koret                Los Angeles
213 Cannon               Atlanta
241 IBM                  New York
440 Spooley              Paxton
475 DEC                  Amherst
999 A E Neumann          Madison

        16 rows found
```