

Assignment II

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 certain scenario. The lab involves extending a given ER diagram, and then translating that extension to the relational model. The student should become familiar with how to create tables in SQL, define primary and foreign keys, and insert and update data into tables.

After the lab, the student should be able to model real world scenarios in terms of EER model and translate an EER diagram into a relational database implementation.

1 Preparations

If needed install Mimer and then set up the Johnson Brothers database. Instructions and scripts can be found at the lab course webpage.

2 Background reading

- Elmasri/Navathe: chapter 3, 4, 8.
- Padron-McCarthy/Risch: chapter 2, 3, 7, 9.

3 The scenario - the 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 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 company's 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 appendixes 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 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.

4 Exercises

IMPORTANT NOTICE: Please be aware that Assignment 3 will be based on the results of these exercises. Good solutions and understanding of them is therefore highly recommended.

- 1) Start by analyzing the ER diagram in Appendix A, and the relational database in Appendix B and Appendix C. Based on the structure of the relational database denote on the diagram

cardinalities ratios of the relationships, such as one-to-one, one-to-many, and many-to-many.

- 2) Extend the ER diagram with an entity type MANAGER that is a sub-class of employee. A manager is an employee that is a 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 the appendix A, translate the extension to the relational model, and implement it in the company database.
- 3) Now that you have changed the schema, also change the data, so that all managers are managers! That is, if you have made a manager table, you should insert data in it. 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. Now, you want to create support for a customer card, with possible credit. The customers will have accounts, where they can deposit and withdraw money, and pay for the purchases. Add the following:
 - Information must be stored about customers such as name, street address, city, and state.
 - Information about accounts such as account number, balance, and allowed credit.
 - Information about account deposits/withdrawals such as transaction number, account number, date and time of deposit/withdrawal, amount, 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, called for example TRANSACT. This entity type represents not only sales, but also deposits and withdrawals. You may want to drop the table debit, and create a new table for the new information.
 - 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 extension in your Mimer database. 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 ...
```

Refer to MIMER SQL Language Reference for details. Also look in the files that you loaded the original database from.

5 Handing in solutions

Hand in your modifications to the database schema by extending and modifying the ER diagram given in Appendix A (possibly by hand) and by adding new tables to the ones in Appendix B. Hand in:

- Your new EER diagram;
- 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;
- Motivate why your relations are in BCNF by specifying all functional dependencies.

6 Appendices

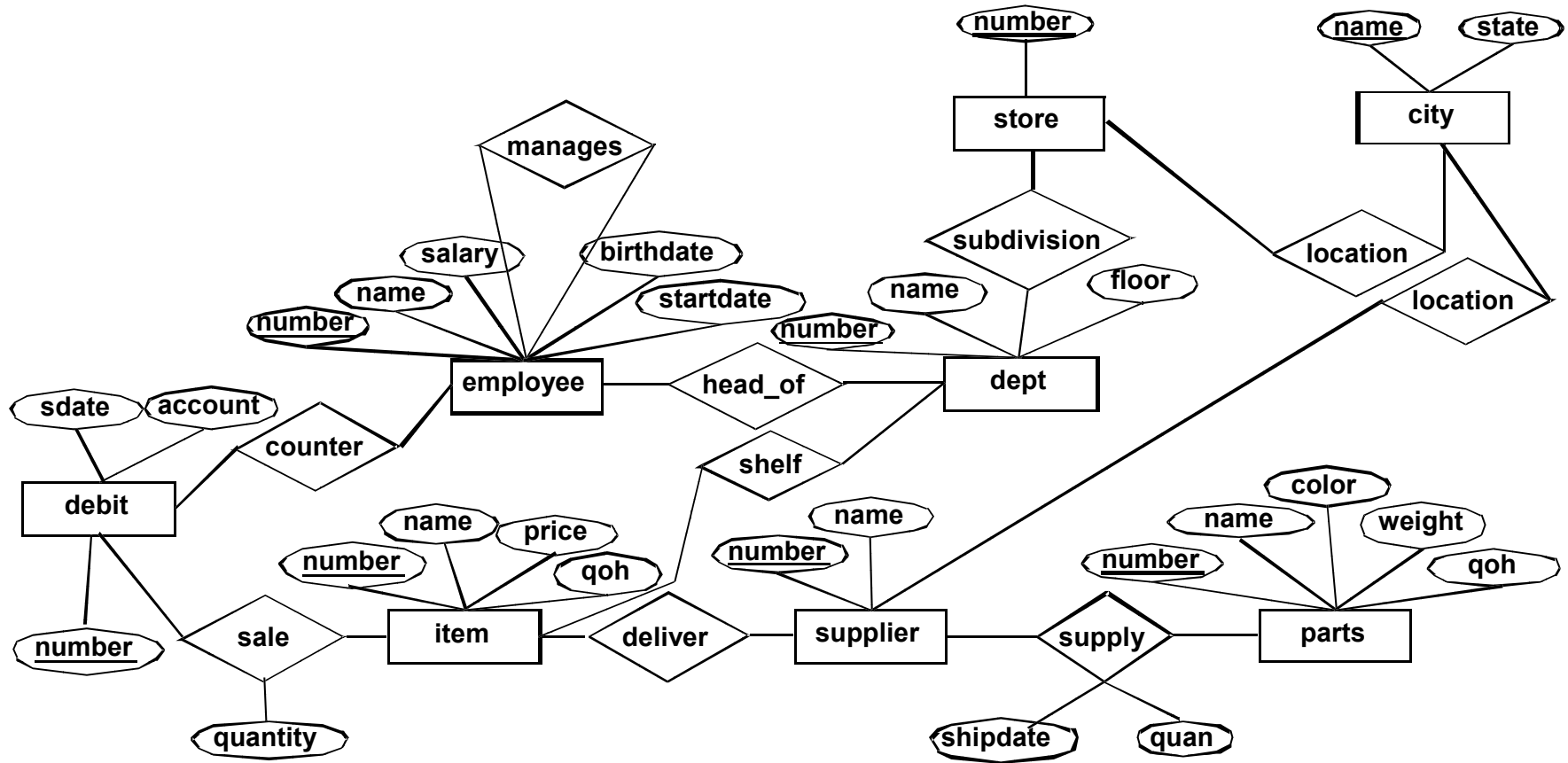
Appendix A: An ER diagram of the existing Jonson Brothers company database

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

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

Appendix A:

E/R diagram of the existing company database:



Appendix B:

The schema for the existing company database

```
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),
 dept INTEGER NOT NULL,
 price INTEGER,
 qoh INTEGER CONSTRAINT ck_item_qoh CHECK (qoh >= 0),
 supplier INTEGER NOT NULL);

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 NOT NULL);

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 item
ADD CONSTRAINT fk_item_dept FOREIGN KEY (dept) REFERENCES dept (number);
```

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```
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 lab 2, 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 database:

```
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

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```

SELECT * FROM item;
      NUMBER NAME                DEPT    PRICE    QOH    SUPPLIER
=====
      11 Wash Cloth                1         75     575     213
      19 Bellbottoms              43        450     600     33
      21 ABC Blocks                 1         198     405     125
      23 1 lb Box                   10        215     100     42
      25 2 lb Box, Mix              10        450     75      42
      26 Earrings                   14       1000     20     199
      43 Maze                       49        325     200     89
      52 Jacket                     60       3295     300     15
     101 Slacks                     63       1600     325     15
     106 Clock Book                 49        198     150     125
     107 The 'Feel' Book            35        225     225     89
     115 Gold Ring                  14       4995     10     199
     118 Towels, Bath               26        250    1000     213
     119 Squeeze Ball              49        250     400     89
     120 Twin Sheet                 26        800     750     213
     121 Queen Sheet                26       1375     600     213
     127 Ski Jumpsuit              65       4350     125     15
     165 Jean                       65        825     500     33
     258 Shirt                      58        650    1200     33
     301 Boy's Jean Suit           43       1250     500     33
  
```

20 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;
      DEBIT    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    10000000
     100582 1995-01-15                1110   14356540
     100586 1995-01-16                 35    14096831
     100592 1995-01-17                129    10000000
     100593 1995-01-18                 13   11652133
     100594 1995-01-18                215   12591815
  
```

6 rows found

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```
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 Spooly          Paxton
475 DEC             Amherst
999 A E Neumann     Madison
```

16 rows found