CS 374 Database Systems **James Madison University**
Sample Midterm **Fall 2025**

Instructions. Answer all of the following questions. This is a “closed book” examination, and you must work entirely on your own. You may not use a computing or communications device of any kind.

Please tear off the last two pages from the staple. Most questions refer to these supplementary pages.

This work complies with the JMU Honor Code.

Name: _____ Signature: _____

Question 1: Read ER Diagram

The following questions are about the Veterinarian ER Model. The word “vet” is short for veterinarian.

- (3 pts) How is a prescription uniquely identified? Explain.

  EmpID, PetID, DrugName
  The keys come from the 2 identifying relationships plus the partial key

- (3 pts) What are the minimum and maximum number of pets that may attend a specific appointment? Explain.

  0 to N pets can attend an appointment
  The 0-N connector from pet to appointment tells us this

- (3 pts) Is it possible to have a prescription without a vet? Explain.

  No
  Since the vet is an identifying relationship for the prescription, it can’t exist without it.
  Also the 1-1 connector tells us that a prescription is associated with exactly 1 vet.

- (3 pts) Is it possible to have an appointment without a vet? Explain.

  Yes
  The appointment is connected to 0 or 1 vet.

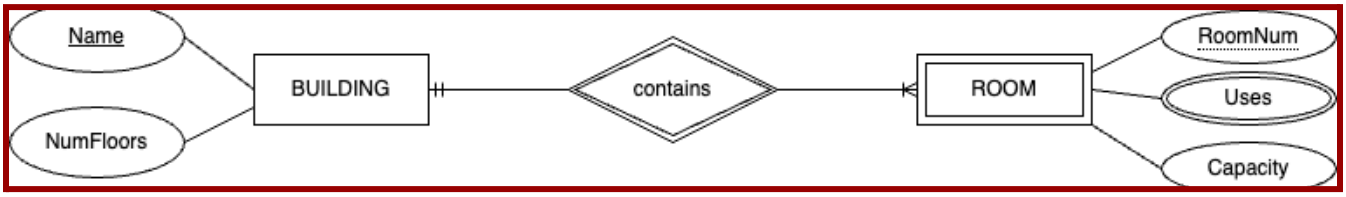
- (3 pts) Is it possible for a vet to exist that has never held an appointment and never prescribed a drug? Explain.

  Yes
  A vet is associated with 0 or more appointments and 0 or more prescriptions, so there could be a vet associated with 0 of both.

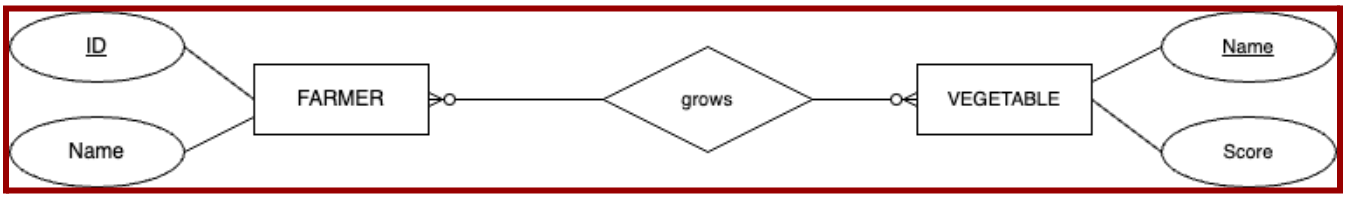
Question 2: Draw ER Diagrams

Draw an ER diagram for each of the following sets of requirements. Each set is independent and involves exactly 2 entities. Pay attention to indicators about both the cardinality and participation constraints. Use the Chen notation components with the crows foot connectors, as shown in the ER Diagram Notation Key.

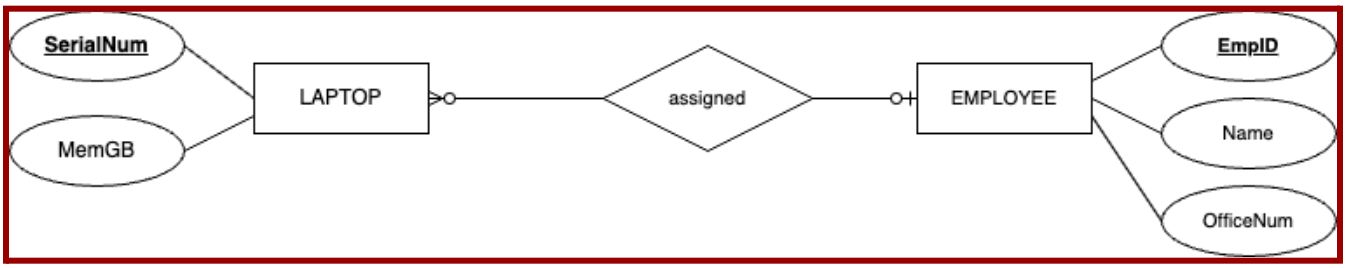
- (5 pts) **Buildings** have a unique name and a number of floors. The **rooms** in every building are numbered starting with room 100 on the first floor. A room has a capacity and several possible uses.



- (5 pts) A **farmer** has an ID and a name. A farmer may grow several different kinds of **vegetables**. Each vegetable type has a unique name and a nutrition score. Several farmers may grow the same vegetable types.



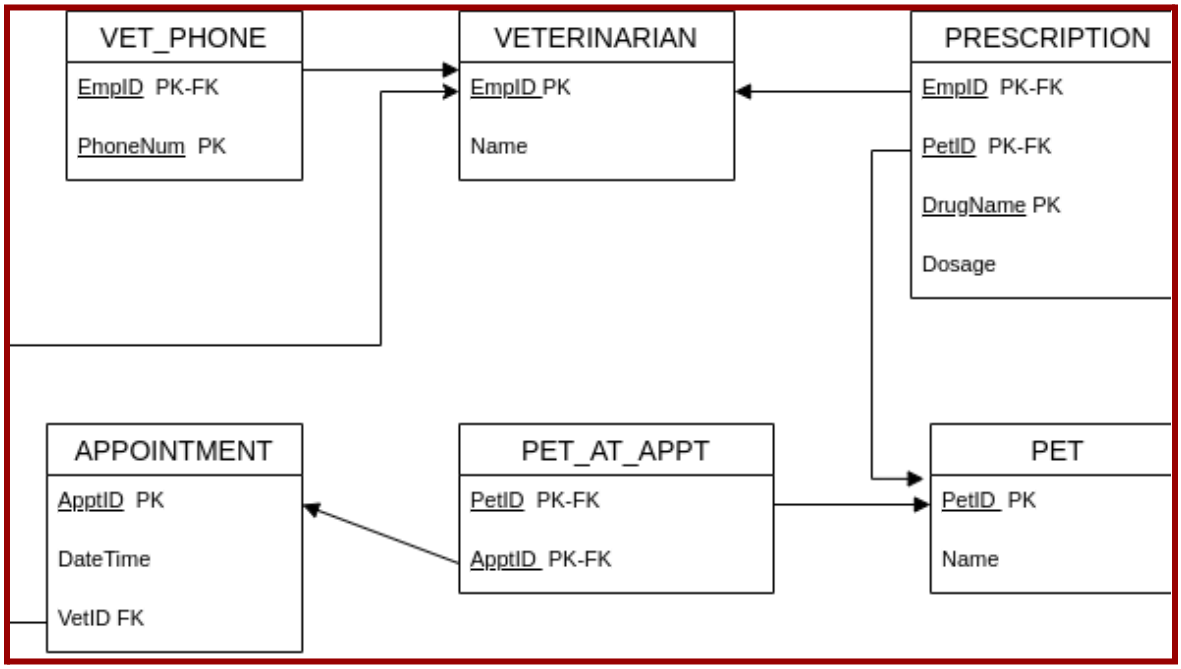
- (5 pts) **Laptops** have a unique serial number, and a memory size in GB. A laptop can be assigned to an **employee**, but several extra laptops are always in the inventory. An employee has a unique ID, a name, and an office number. Some employees don't need a laptop, while other employees need several laptops.



Question 3: Relational Mapping

(15 pts) Draw a relational database diagram for the Veterinarian ER Model. **Do not deviate from the original model shown.**

Your diagram should have arrows only from the FKs pointing to the PKs that they reference, and no other connectors. You may underline the primary key columns, but please also mark them with PK for readability (Ex: FieldName PK). Also mark foreign key columns with FK. You may "stack" the table columns horizontally (as shown in the Company Database Schema) or vertically (like we did in class). You do not need to show data types for the columns.



Question 4: Database Updates

Write the following SQL statements using the Company Database. For each statement, indicate whether or not a constraint would be violated given the current data in the database. **Briefly** explain the reason for the violation or why there is no violation.

Assume that each statement runs independently – you do not need to keep track of how the database changes across statements.

- (2.5 pts) Write a single INSERT statement to add a new DEPT_LOCATION for department number **4** at the location **Harrisonburg**.

```
INSERT INTO DEPT_LOCATION (Dnumber, Dlocation)
VALUES (4, 'Harrisonburg')
```

No violations because dept 4 exists

- (2.5 pts) Write a single INSERT statement to add a new DEPARTMENT with the name **Analysis**, number **3**, and manager ssn **111111111**.

```
INSERT INTO DEPARTMENT (Dname, Dnumber, Mgr_ssn)
VALUES ('Analysis', 3, 111111111)
```

There will be a referential integrity violation because the Mgr_ssn FK must refer to an existing employee, and no employee 111111111 exists.

- (2.5 pts) Project **2** is behind schedule, so write a single UPDATE statement to have everyone who works on project **2** spend **3** additional hours.

```
UPDATE WORKS_ON
SET Hours = Hours + 3
WHERE Pno = 2
```

No violation because there are no references to the works_on table

- (2.5 pts) Write a single UPDATE statement so that employee **123456789** works **32.5** hours on project **40** instead of on project **1**.

```
UPDATE WORKS_ON
SET Pno = 40
WHERE Pno = 1 and Essn = 123456789
```

Referential integrity constraint error because Pno is an FK and project 40 does not exist.

- (2.5 pts) Since employee **888665555** is not working any hours, write a single DELETE statement to remove them from working on project **20**.

```
DELETE FROM WORKS_ON
WHERE Essn = 888665555
  AND Pno = 20
```

No violation because there are no references to the works_on table

- (2.5 pts) Write a single DELETE statement to delete exactly **1** employee of your choice, so that your statement will cause a referential integrity violation. Explain your choice.

```
DELETE FROM EMPLOYEE
WHERE Ssn = 333445555
```

This employee has related rows in the WORKS_ON, DEPARTMENT, EMPLOYEE and DEPENDENT tables.
Any answer where the Ssn is referenced in the EMPLOYEE, DEPENDENT, DEPARTMENT or EMPLOYEE table itself, and the explanation.

Question 5: SQL Joins, etc.

(20 pts) Write the following SQL query using the TPC-H database:

Which parts supplied by Canadian suppliers have never been ordered? Note: The name CANADA is spelled with all capital letters in the database. Sort the results by the part's retail price (ascending).

Hint: If a part has never been ordered from a particular supplier, there won't be any line items for the (partkey, suppkey) pair.

Sample output (first 5 rows):

p_partkey	p_name	p_retailprice
29097	dark khaki burlywood coral thistle	1026.09
73166	moccasin cornsilk papaya cream chartreuse	1139.16
58223	turquoise metallic lawn honeydew saddle	1181.22
10285	pink light antique almond coral	1195.28
87228	cream beige slate brown floral	1215.22

```
SELECT p_partkey, p_name, p_retailprice
FROM part
  JOIN partsupp ON p_partkey = ps_partkey
  JOIN supplier ON ps_suppkey = s_suppkey
  JOIN nation ON s_nationkey = n_nationkey
  LEFT JOIN lineitem ON ps_partkey = l_partkey AND ps_suppkey = l_suppkey
WHERE n_name = 'CANADA'
  AND l_orderkey IS NULL  -- or any other column in lineitem
ORDER BY p_retailprice;
```

Note: This year's midterm may have two shorter queries (10 pts each) for Question 5.

Question 6: SQL Aggregation

(20 pts) Write the following SQL query using the TPC-H database:

For each customer in the AMERICA region, what is the average total price of all their orders? Limit the results to 200 rows. Sort the results by the average total price (ascending).

Hint: You will need to rename the last column to avg_orderprice (that column name is not in the database).

Sample output (first 5 rows):

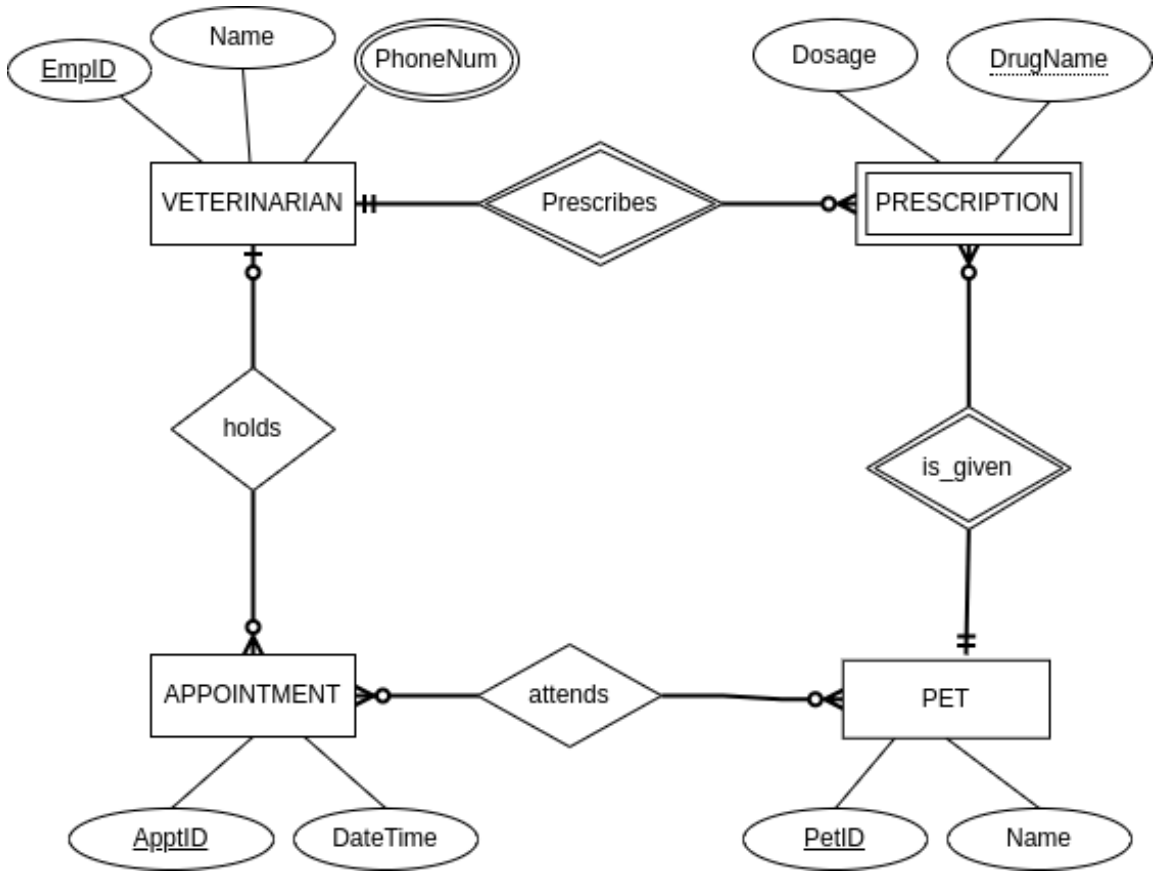
c_custkey	c_name	avg_orderprice
43360	Customer#000043360	28123.740000000000
77345	Customer#000077345	28200.885000000000
83204	Customer#000083204	41002.312500000000
145265	Customer#000145265	42553.746000000000
12314	Customer#000012314	47008.803333333333

```
SELECT c_custkey, c_name, avg(o_totalprice) AS avg_orderprice
FROM customer
  JOIN nation ON c_nationkey = n_nationkey
  JOIN region ON n_regionkey = r_regionkey
  JOIN orders ON c_custkey = o_custkey
WHERE r_name = 'AMERICA'
GROUP BY c_custkey
ORDER BY avg_orderprice
LIMIT 200;
```

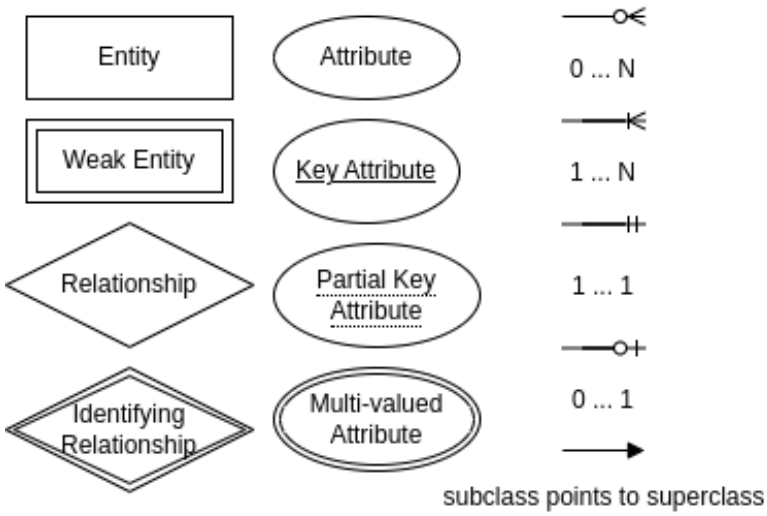
Note: This year's midterm may have two shorter queries (10 pts each) for Question 6.

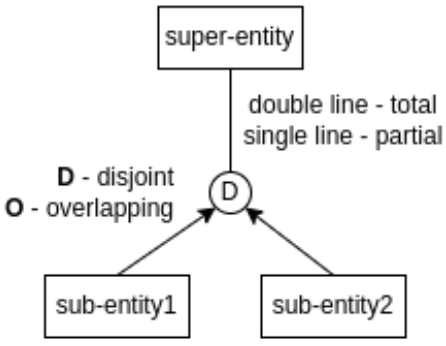
Supplementary Pages

Veterinarian ER Model



EER Diagram Notation





Company Database: Schema

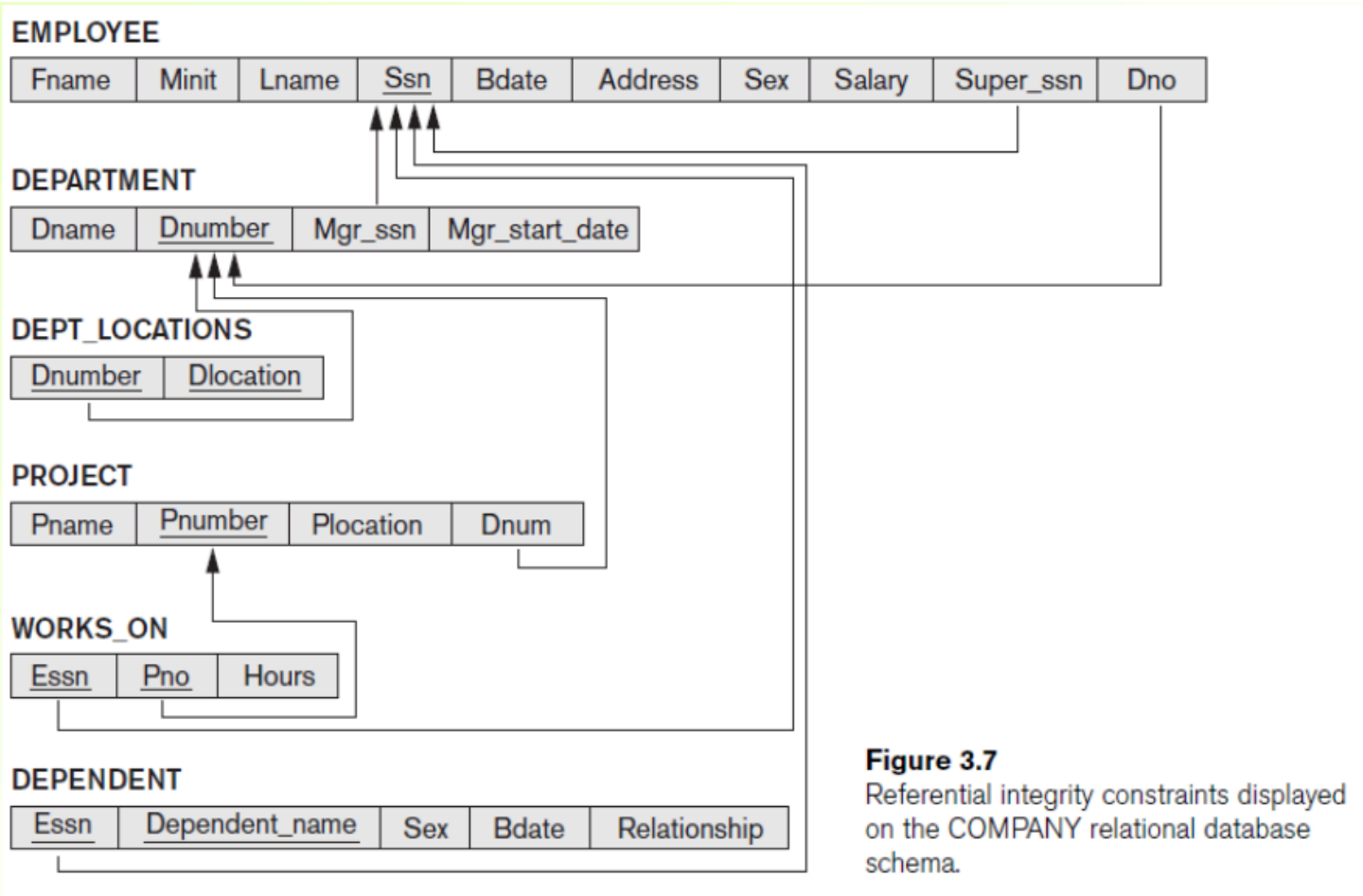


Figure 3.7
Referential integrity constraints displayed on the COMPANY relational database schema.

Note: In this diagram format, the column names are stacked horizontally instead of vertically. The data types are not shown.

Company Database: Data

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

The TPC-H Database