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CS 480
Database Systems
Fall 2019

# Homework #2

**Complete By:** Wednesday, September 11th @ 5:00pm
**Submission:** collected at beginning of class on paper or submitted digitally through Gradescope

## Reading Tables

On the following two pages is a set of data that was stored in a database. There are three tables extracted from the database which store between them some information the company keeping the database finds useful. Read through this data in order to answer the questions that follow.

**Employee Table**

| Employee_ID | Employee_Fname | Employee_Lname | Employee_HireDate | Employee_Title |
|---|---|---|---|---|
| 2345 | Brian | Oates | 2/14/99 | DBA |
| 3373 | Franklin | Johnson | 3/15/06 | Purchasing Agent |
| 4893 | Patricia | Richards | 6/11/08 | DBA |
| 6234 | Jasmine | Patel | 8/10/09 | Programmer |
| 8273 | Marco | Bienz | 7/28/10 | Analyst |
| 9002 | Wade | Gather | 5/20/14 | Clerk |
| 9283 | Juan | Chavez | 7/4/14 | Clerk |
| 9382 | Susan | Mathis | 8/2/14 | Database Programmer |
| 13383 | Raymond | Matthews | 3/12/16 | Programmer |

**Certified Table**

| Employee_ID | Skill_ID | Certified_Date |
|---|---|---|
| 2345 | 100 | 2/14/04 |
| 2345 | 110 | 8/9/05 |
| 2345 | 180 | 2/14/07 |
| 3373 | 120 | 6/20/13 |
| 4893 | 180 | 6/11/08 |
| 4893 | 220 | 9/20/14 |
| 6234 | 110 | 8/10/09 |
| 6234 | 200 | 8/10/09 |
| 6234 | 210 | 1/29/14 |
| 8273 | 110 | 3/8/11 |
| 8273 | 190 | 8/19/14 |
| 9002 | 110 | 5/16/15 |
| 9002 | 120 | 5/16/15 |
| 9382 | 140 | 8/2/14 |
| 9382 | 210 | 8/2/14 |
| 9382 | 220 | 5/1/15 |
| 13383 | 170 | 3/12/16 |

**Skill Table**

| Skill_ID | Skill_Name | Skill_Description |
|---|---|---|
| 100 | Basic Database Management | Create and manage database user accounts |
| 110 | Basic Web Design | Create and maintain HTML and CSS documents |
| 120 | Advanced Spreadsheets | Use of advanced functions, user-defined functions, and macroing |
| 130 | Basic Process Modeling | Create core business process models using standard libraries |
| 140 | Basic Database Design | Create simple data models |
| 150 | Master Database Programming | Create integrated trigger and procedure packages for a distributed environment |
| 160 | Basic Spreadsheets | Create single tab worksheets with basic formulas |
| 170 | Basic C# Programming | Create single-tier data aware modules |
| 180 | Advanced Database Management | Manage Database Server Clusters |
| 190 | Advanced Process Modeling | Evaluate and Redesign cross-functional and external business processes |
| 200 | Advanced C# Programming | Create multi-tier applications using multi-threading |
| 210 | Basic Database Manipulation | Create simple data retrieval and manipulation statements in SQL |
| 220 | Advanced Database Manipulation | Use of advanced data manipulations methods for multi-table inserts, sets operations and correlated subqueries. |

**Position Requirements**

| Employee_Title | Skill_ID |
|---|---|
| Clerk | 100 |
| Programmer | 110 |
| Programmer | 130 |
| Programmer | 170 |
| Analyst | 120 |
| Analyst | 130 |
| Analyst | 160 |
| Analyst | 140 |
| Purchasing Agent | 160 |
| Database Programmer | 140 |
| Database Programmer | 210 |
| Database Programmer | 100 |
| Database Programmer | 220 |
| DBA | 180 |
| DBA | 150 |

## Interpreting Relational Algebra (30 points)

**Produce the tables generated by executing the following Relational Algebra Queries on the data set provided on the previous pages.**

1. $\Pi_{\text{Employee\_FName,Employee\_LName}}(\text{Employee})$

| Employee_Fname | Employee_Lname |
|---|---|
| Brian | Oates |
| Franklin | Johnson |
| Patricia | Richards |
| Jasmine | Patel |
| Marco | Bienz |
| Wade | Gather |
| Juan | Chavez |
| Susan | Mathis |
| Raymond | Matthews |

1. $\Pi_{\text{Employee\_ID}}\, \sigma_{\text{Employee\_HireDate}>=1/1/2010}(\text{Employee})$

| Employee_ID |
|---|
| 8273 |
| 9002 |
| 9283 |
| 9382 |
| 13383 |

2. $\Pi_{\text{Employee\_ID, Skill\_Name}}(\text{Certified} \bowtie \text{Skill})$

| Employee_ID | Skill_Name |
|---|---|
| 2345 | Basic Database Management |
| 2345 | Basic Web Design |
| 2345 | Advanced Database Management |
| 3373 | Advanced Spreadsheets |
| 4893 | Advanced Database Management |
| 4893 | Advanced Database Manipulation |
| 6234 | Basic Web Design |
| 6234 | Advanced C# Programming |
| 6234 | Basic Database Manipulation |
| 8273 | Basic Web Design |
| 8273 | Advanced Process Modeling |
| 9002 | Basic Web Design |
| 9002 | Advanced Spreadsheets |
| 9382 | Basic Database Design |
| 9382 | Basic Database Manipulation |
| 9382 | Advanced Database Manipulation |
| 13383 | Basic C# Programming |

## Writing Relational Algebra (70 points)

**For each of the questions in this section, you will write a relational algebra query that generates the table or answer to the query.**

3. Build a Relational Algebra expression that will produce the following table. Keep in mind the properties of relations. (5 points)

| Employee_Title |
|---|
| Analyst |
| Clerk |
| Programmer |
| DBA |
| Purchasing Agent |
| Database Programmer |

$\Pi_{\text{Employee\_Title}}$ (Employee)

1. What is each Employee's title and first name? (5 points)

$\Pi_{\text{Employee\_FName, Employee\_Title}}$ (Employee)

4. When were certifications given for training in Basic Web Design?

$\Pi$ Certified_Date($\sigma$ Skill_Name = "Basic Web Design"(Certified $\bowtie$ Skill))

or

$\Pi$ Certified_Date($\sigma$ Skill_ID = 110(Certified $\bowtie$ Skill))

2. What skill(s) is Jasmine Patel certified in? List the names of the skills.

$\Pi$ Skill_Name($\sigma$ Employee_Fname = "Jasmine"($\sigma$ Employee_Lname = "Patel"((Employee $\bowtie$ Certified) $\bowtie$ Skill)))

Or

$\Pi$ Skill_Name($\sigma$ Employee_ID = 6345((Employee $\bowtie$ Certified) $\bowtie$ Skill))

3. Who are the employee(s) who are certified in Advanced Database Management? List the first and last names.

   $\Pi$ Employee_FName, Employee_LName($\sigma$ Skill_Name = "Advanced Database Management"( ((Employee $\bowtie$ Certified) $\bowtie$ Skill)))

   Or

   $\Pi$ Employee_FName, Employee_LName($\sigma$ Skill_ID = 180( ((Employee $\bowtie$ Certified) $\bowtie$ Skill)))

4. List the Titles of the employees alongside the Names of the skills for certifications given before 06/01/2009.

   $\Pi$ Employee_Title , Skill_Name($\sigma$ Certified_Date < 06/01/2009((Employee $\bowtie$ Certified) $\bowtie$ Skill))

5. List the skills the employee with Employee_ID stored in the variable E does not possess certification for that they should according to their title and the Position Requirements table.
   For example, Brian Oates has the title of DBA, but the DBA position requires training in both Advanced Database Management and Master Database Programming, and Brian only has training in Advanced Database Management.

   The output table if E stored 2345 would be this

| Skill_Name |
| --- |
| Master Database Programming |

Let $t$ =

$$\text{Employee} \bowtie (\text{Skill} \bowtie (\text{Position Requirements} - \Pi_{\text{Employee\_Title , Skill\_ID}}(\text{Employee} \bowtie \text{Skill})))$$

And

$$S = \Pi_{\text{Employee\_ID, Skill\_Name}}(t)$$

And

$$\rho_{\text{x (E, Skill\_Name)}}(S)$$

So, the required relational algebra query is:

$$\rho_{\text{x (E, Skill\_Name)}}(\Pi_{\text{Employee\_ID, Skill\_Name}}(\text{Employee} \bowtie (\text{Skill} \bowtie (\text{Position Requirements} - \Pi_{\text{Employee\_Title , Skill\_ID}}(\text{Employee} \bowtie \text{Skill})))))$$

6. Write a relational algebra expression which constructs a table recording which employees are senior to each other, specifically for employees who are Clerks.
   For example, Wade Gather is senior to Juan Chavez because Wade was hired before Juan. If a Sam Smith was hired today, with ID 11111, Juan would be senior to Sam and Wade would be senior to both Sam and Juan.
   The table should contain two columns, the ID of the senior employee, and the ID of the Junior employee, for every pair of employees who are related by seniority.

   For example, the table for this data set with the addition of Sam would be this

| Senior_ID | Junior_ID |
|---|---|
| 9002 | 9823 |
| 9002 | 11111 |
| 9283 | 11111 |

$\rho$ c (Senior ID, Junior ID) ($\Pi$ a.Employee_ID, b.Employee_ID ($\sigma$ a.Employee_HireDate < b.Employee_HireDate ^ a.Employee_Title = “Clerk” ^ b.Employee_Title = “Clerk” ($\rho$ a (Employee) X $\rho$ b (Employee)))