INFO20003 Database Systems

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Lecture 08
SQL

Yesterday's solutions 1/3

- Find all pairs of sailors in which the <u>older</u> sailor has a <u>lower</u> rating

$$r\ (S1(1 \longrightarrow sid1, 2 \longrightarrow sname1, 3 \longrightarrow rating1, 4 \longrightarrow age1), Sailors)$$

$$r\ (S2(1 \longrightarrow sid2, 2 \longrightarrow sname2, 3 \longrightarrow rating2, 4 \longrightarrow age2), Sailors)$$

$$\pi_{sname1, sname2}(S1 \bowtie_{age1 > age2 \wedge rating1 < rating2} S2)$$

Yesterday's solutions 2/3

1. Find the name of all sailors whose rating is above 9

$$p_{sname}(s_{rating>9}(Sailors))$$

2. Find all sailors who reserved a boat prior to November 1, 1996

$$p_{sname}(Sailors \bowtie s_{day<'11/1/96'}(Reserves))$$

3. Find (the names of) all boats that have been reserved at least once

$$p_{bname}(Boats \bowtie Reserves)$$

Yesterday's solutions 3/3

4. Find all pairs of sailors with the same rating

$$r_{(S1(1 \longrightarrow sid1, 2 \longrightarrow sname1, 3 \longrightarrow rating1, 4 \longrightarrow age1), Sailors)}$$

$$r_{(S2(1 \longrightarrow sid2, 2 \longrightarrow sname2, 3 \longrightarrow rating2, 4 \longrightarrow age2), Sailors)}$$

$$p_{sname1, sname2}(S1 \bowtie_{rating1 = rating2 \wedge sid1 \neq sid2} S2)$$

What is SQL

- SQL – or SEQUEL is a language used in relational databases
- Based on relational algebra and relational calculus
- DBMS support CRUD
  - Create, Read, Update, Delete
- SQL supports CRUD
  - Create, Select, Update, Delete commands
- Other info
  - You can see the 2011 standard of SQL at
    - http://www.jtc1sc32.org/doc/N2151-2200/32N2153T-text_for_ballot-FDIS_9075-1.pdf
  - Wikipedia has several sections on SQL (good for generic syntax)
    - http://en.wikipedia.org/wiki/Category:SQL_keywords

SQL Language

- Provides the following capabilities (just what the DBMS needs to run)
  - Data Definition Language (DDL)
    - To define and set up the database
    - CREATE, ALTER, DROP
      - Also TRUNCATE, RENAME
  - Data Manipulation Language (DML)
    - To maintain and use the database
    - SELECT, INSERT, DELETE, UPDATE
      - MySQL also provides others…. Eg REPLACE
  - Data Control Language (DCL)
    - To control access to the database
      - GRANT, REVOKE
  - Other Commands
    - Administer the database
    - Transaction Control

How We Use SQL

- In Physical Design/Implementation of the database
  - Take the tables we design in physical design
  - Implement these tables in the database using create commands
- In Use of the database
  - Use Select commands to read the data from the tables, link the tables together etc
  - Use alter, drop commands to update the database
  - Use insert, update, delete commands to update data in the database

SQL Context in Development Process

1.

```
CREATE TABLE BankHQ (
    BankHQID        INT(4)          AUTO_INCREMENT,
    HQAddress       VARCHAR(300)    NOT NULL,
    OtherHQDetails  VARCHAR(500),
PRIMARY KEY (BankHQID)
)
```

2.

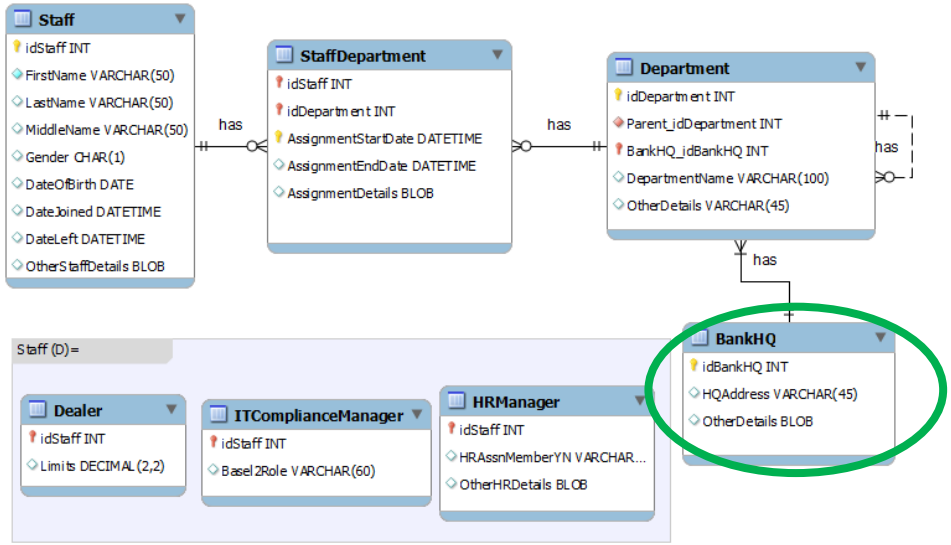
```
INSERT INTO BankHQ VALUES
    (DEFAULT,"23 Charles St Peterson North 2022", 'Main Branch');
INSERT INTO BankHQ VALUES
    (DEFAULT,"213 Jones Rd Parkville North 2122", 'Sub Branch');
```

3.

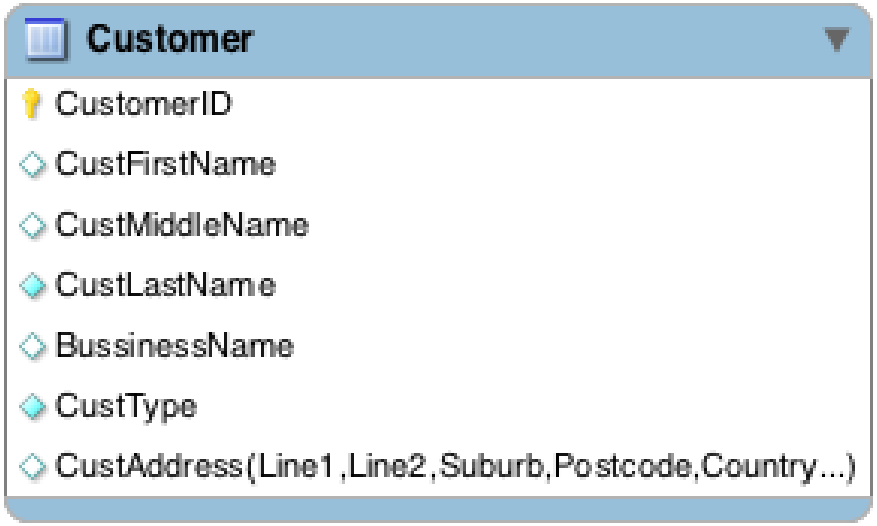
```
1 • select * from BANKHQ
```

Overview | Output | Snippets | Query 3 Result

BankHQID	HQAddress	OtherHQDetails
1	23 Charles St Peterson North 2022	Main Branch
2	213 Jones Rd Parkville North 2122	Sub Branch



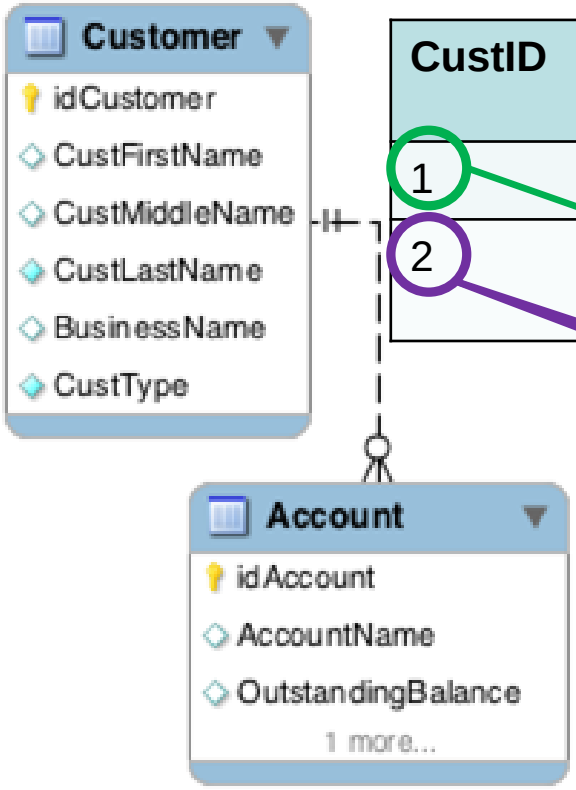
Create Table: Review




```
CREATE TABLE Customer (
  CustomerID        smallint                    auto_increment,
  CustFirstName     varchar(100),
  CustMiddleName    varchar(100),
  CustLastName      varchar(100)                NOT NULL,
  BusinessName      varchar(200),
  CustType          enum('Personal','Company')  NOT NULL,
  PRIMARY KEY  (CustomerID)
);
```

Foreign keys: Review

- We looked at Customer
  - A customer can have a number of Accounts
  - The tables get linked through a foreign key



CustID	Customer FirstName	CustMiddle Name	CustLast Name	Business Name	CustType
1	Peter		Smith		Personal
2	James		Jones	JJ Enterprises	Company

AccountID	AccountName	Outstanding Balance	CustID
01	Peter Smith	245.25	1
05	JJ Ent.	552.39	2
06	JJ Ent. Mgr	10.25	2

SQL CREATE Statement – With FK

```sql
CREATE TABLE Account (
  AccountID              smallint        auto_increment,
  AccountName            varchar(100)    NOT NULL,
  OutstandingBalance     DECIMAL(10,2)   NOT NULL,
  CustomerID             smallint        NOT NULL,
  PRIMARY KEY  (AccountID),
  FOREIGN KEY (CustomerID) REFERENCES Customer(CustomerID)
        ON DELETE RESTRICT
        ON UPDATE CASCADE
);
```

Insert Data

```
INSERT INTO Customer
    (CustFirstName, CustLastName, CustType)
    VALUES ("Peter", "Smith", 'Personal');

INSERT INTO Customer
    VALUES (DEFAULT,"James", NULL, "Jones",
            "JJ Enterprises", 'Company');
```

No column specification means ALL columns will be entered

Customer

CustID	CustomerFirst Name	CustMiddle Name	CustLastName	BusinessName	CustType
1	Peter		Smith		Personal
2	James		Jones	JJ Enterprises	Company

What does NULL mean?

Null Island: The Busiest Place That Doesn't Exist:
https://www.youtube.com/watch?v=bjvIpI-1w84
by the channel MinuteEarth

Query Table

```
INSERT INTO Customer
    VALUES (DEFAULT,"", NULL, "Smythe",
            "", 'Company');
```

All columns

```
1 • select * from Customer ;
```

erview | Output | Snippets | Query 3 Result | Query 4 Result

Fetched 3 records. Duration: 0.015 sec, fe

CustomerID	CustFirstName	CustMiddleName	CustLastName	BusinessName	CustType
1	Peter	NULL	Smith	NULL	Personal
2	James	NULL	Jones	JJ Enterprises	Company
3		NULL	Smythe		Company

The SELECT Statement – Detail

- A cut down version of the SELECT statement – MySQL

- SELECT [ALL | DISTINCT] *select_expr* [, *select_expr* ...]
  - List the columns (and expressions) that are returned from the query
- [FROM *table_references*]
  - Indicate the table(s) or view(s) from where the data is obtained
- [WHERE *where_condition*]
  - Indicate the conditions on whether a particular row will be in the result
- [GROUP BY {*col_name* | *expr* } [ASC | DESC], ...]
  - Indicate categorisation of results
- [HAVING *where_condition*]
  - Indicate the conditions under which a particular category (group) is included in the result
- [ORDER BY {*col_name* | *expr* | *position*} [ASC | DESC], ...]
  - Sort the result based on the criteria
- [LIMIT {[*offset*,] *row_count* | *row_count* OFFSET *offset*}]
  - Limit which rows are returned by their return order (ie 5 rows, 5 rows from row 2)

Select Examples

Customer
- CustomerID INT
- CustomerFirstName VARCHAR(100)
- CustomerMiddleName VARCHAR(100)
- CustomerLastName VARCHAR(100)
- BussinessName VARCHAR(100)
- CustomerType CHAR(1)

5 more...

SELECT * FROM Customer;
= Give me all information you have about customers

SQL

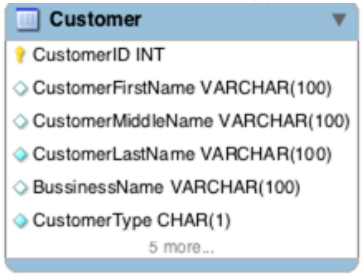
```
SELECT * FROM Customer;
```

RESULT

Edit: Export: Autosize:

CustomerID	CustFirstName	CustMiddleName	CustLastName	BusinessName	CustType
1	Peter	NULL	Smith	NULL	Personal
2	James	NULL	Jones	JJ Enterprises	Company
3	Akin	NULL	Smithies	Bay Wart	Company
4	Julie	Anne	Smythe	Konks	Company
5	Jen	NULL	Smart	BRU	Company
6	Lim	NULL	Lam	NULL	Personal
7	Kim	NULL	Unila	Saps	Company
8	James	Jay	Jones	JJ's	Company
9	Keith	NULL	Samson	NULL	Personal
NULL	NULL	NULL	NULL	NULL	NULL

Select Examples : Projection



In Relational Algebra:

$$\pi_{CustLastName}(Customer)$$

In SQL:

SELECT CustLastName
FROM Customer;

SQL

```
SELECT CustLastName FROM Customer;
```

Result

Export Autosize

CustLastName
Smith
Jones
Smithies
Smythe
Smart
Lam
Unila
Jones
Samson

Select Examples: Selection

In Relational Algebra:

$$\sigma_{cond1 \wedge cond2 \vee cond3}(Rel)$$

In SQL:

WHERE cond1 AND cond2
OR cond3

In Relational Algebra:

$$\pi_{CustLastName}(\sigma_{CustLastName="Smith"}(Customer))$$

In SQL:

SELECT CustLastName
FROM Customer
WHERE CustLastName = "Smith";

SQL

```
SELECT CustLastName FROM Customer
    WHERE CustLastName = "Smith";
```

Result

Export: Autosize

CustLastName
Smith

Select Examples: Selection LIKE

LIKE "REG_EXP"

% Represents zero, one, or multiple characters
_ Represents a single character

Examples:

WHERE CustomerName LIKE 'a%'	Finds any values that starts with "a"
WHERE CustomerName LIKE '%a'	Finds any values that ends with "a"
WHERE CustomerName LIKE '%or%'	Finds any values that have "or" in any position
WHERE CustomerName LIKE '_r%'	Finds any values that have "r" in the second position
WHERE CustomerName LIKE 'a_%_%'	Finds any values that starts with "a" and are at least 3 characters in length
WHERE ContactName LIKE 'a%o'	Finds any values that starts with "a" and ends with "o"

SQL:

```
SELECT CustLastName FROM Customer
    WHERE CustLastName LIKE "Sm%";
```

Export: Autosize

CustLastName
Smith
Smithies
Smythe
Smart

Aggregate Functions

These functions operate on the multiset of values in a column of a relation (table) and return a single value

- AVG()
  - Average value
- MIN()
  - Minimum value
- MAX()
  - Maximum value
- COUNT()
  - Number of values
- SUM()
  - Sum of values

- Plus others
  - http://dev.mysql.com/doc/refman/5.5/en/group-by-functions.html
- All of these except for COUNT() ignore null values and return null if all values are null. COUNT() counts the rows not the values and thus even if the value is NULL it is still counted.

Select Examples: Count/AVG

COUNT() - returns number of records
AVG() - average of the values

Examples:

```
SELECT COUNT(CustomerID)
FROM Customer;
```

= How many customers do we have (cardinality)

```
SELECT AVG(OutstandingBalance)
FROM Account;
```

= What is the average balance of ALL ACCOUNTS

```
SELECT AVG(OutstandingBalance)
FROM Account
WHERE CustomerID= 1;
```

= What is the average balance of Accounts of Customer 1

```
SELECT AVG(OutstandingBalance)
FROM Account
GROUP BY CustomerID;
```

= What is the average balance **PER CUSTOMER**

Select Examples: Count/Group By

SQL

```sql
SELECT CustType, Count(CustomerID)
    FROM Customer
    GROUP BY CustType;
```

RESULT

Export: Autosize:

CustType	Count(CustomerID)
Personal	3
Company	6

SQL

```sql
SELECT CustType, Count(CustomerID) AS Count
    FROM Customer
    GROUP BY CustType;
```

RESULT

Export: Autosize:

CustType	Count
Personal	3
Company	6

Select Examples: Order by

ORDER BY ASC/DESC

(ASC is default)

SQL

```
SELECT CustLastName, CustType
    FROM Customer
    ORDER BY CustLastName;
```

```
SELECT CustLastName, CustType
    FROM Customer
    ORDER BY CustLastName DESC;
```

RESULT

Export

CustLastName	CustType
Jones	Company
Jones	Company
Lam	Personal
Samson	Personal
Smart	Company
Smith	Personal
Smithies	Company
Smythe	Company
Unila	Company

Export

CustLastName	CustType
Unila	Company
Smythe	Company
Smithies	Company
Smith	Personal
Smart	Company
Samson	Personal
Lam	Personal
Jones	Company
Jones	Company

Select Examples: Limit and Offset

- LIMIT number - limits the output size
- OFFSET number - skips first 'number' records

```
SELECT CustLastName, CustType
    FROM Customer
    ORDER BY CustLastName
    LIMIT 5;
```

Export:

CustLastName	CustType
Jones	Company
Jones	Company
Lam	Personal
Samson	Personal
Smart	Company

```
SELECT CustLastName, CustType
    FROM Customer
    ORDER BY CustLastName
    LIMIT 5
    OFFSET 3;
```

Export:

CustLastName	CustType
Samson	Personal
Smart	Company
Smith	Personal
Smithies	Company
Smythe	Company

CustLastName	CustType
Jones	Company
Jones	Company
Lam	Personal
Samson	Personal
Smart	Company
Smith	Personal
Smithies	Company
Smythe	Company
Unila	Company

SQL SELECT Statements: Join

- Need to join the 2 tables together somehow…
- SELECT * FROM **Rel1, Rel2**;

```
SELECT * FROM Customer, Account;
```

Export: Autosize:

CustomerID	CustFirstName	CustMiddleName	CustLastName	BusinessName	CustType	AccountID	AccountName	OutstandingBalance	CustomerID
1	Peter	NULL	Smith	NULL	Personal	1	Peter Smith	245.25	1
2	James	NULL	Jones	JJ Enterprises	Company	1	Peter Smith	245.25	1
3	Akin	NULL	Smithies	Bay Wart	Company	1	Peter Smith	245.25	1
1	Peter	NULL	Smith	NULL	Personal	2	JJ ENt.	552.39	2
2	James	NULL	Jones	JJ Enterprises	Company	2	JJ ENt.	552.39	2
3	Akin	NULL	Smithies	Bay Wart	Company	2	JJ ENt.	552.39	2
1	Peter	NULL	Smith	NULL	Personal	3	JJ ENt. Mgr	10.25	2
2	James	NULL	Jones	JJ Enterprises	Company	3	JJ ENt. Mgr	10.25	2
3	Akin	NULL	Smithies	Bay Wart	Company	3	JJ ENt. Mgr	10.25	2

This gives the cross product! Not quite what we want…

For every record in the Customer table list every record in the Account table

SQL Joins – Different Types

- Cartesian Product - TableA * TableB
- Inner/Equi join - Join the tables with foreign keys!

```
SELECT * FROM Customer INNER JOIN Account
  ON Customer.CustomerID = Account.CustomerID;
```

CONDITION

Export: Autosize:

CustomerID	CustFirstName	CustMiddleName	CustLastName	BusinessName	CustType	AccountID	AccountName	OutstandingBalance	CustomerID
1	Peter	NULL	Smith	NULL	Personal	1	Peter Smith	245.25	1
2	James	NULL	Jones	JJ Enterprises	Company	2	JJ ENt.	552.39	2
2	James	NULL	Jones	JJ Enterprises	Company	3	JJ ENt. Mgr	10.25	2

- Natural Join
  - Join the tables with foreign keys where the primary key and foreign key have the same name

```
SELECT * FROM Customer NATURAL JOIN Account;
```

Export: Autosize:

CustomerID	CustFirstName	CustMiddleName	CustLastName	BusinessName	CustType	AccountID	AccountName	OutstandingBalance
1	Peter	NULL	Smith	NULL	Personal	1	Peter Smith	245.25
2	James	NULL	Jones	JJ Enterprises	Company	2	JJ ENt.	552.39
2	James	NULL	Jones	JJ Enterprises	Company	3	JJ ENt. Mgr	10.25

SQL Joins – Different Types

- Outer join
  - Join the tables with foreign keys!
  - Can be left or right (see difference below)
  - Includes records that don't match the join from the left/right table

```
SELECT * FROM Customer LEFT OUTER JOIN Account
    ON Customer.CustomerID = Account.CustomerID;
```

Export: Autosize:

CustomerID	CustFirstName	CustMiddleNa	CustLastName	BusinessName	CustType	AccountID	AccountName	OutstandingBalance	CustomerID
1	Peter	NULL	Smith	NULL	Personal	1	Peter Smith	245.25	1
2	James	NULL	Jones	JJ Enterprises	Company	2	JJ ENt.	552.39	2
2	James	NULL	Jones	JJ Enterprises	Company	3	JJ ENt. Mgr	10.25	2
3	Akin	NULL	Smithies	Bay Wart	Company	NULL	NULL	NULL	NULL

```
SELECT * FROM Customer RIGHT OUTER JOIN Account
    ON Customer.CustomerID = Account.CustomerID;
```

Export: Autosize:

CustomerID	CustFirstName	CustMiddleName	CustLastName	BusinessName	CustType	AccountID	AccountName	OutstandingBalance	CustomerID
1	Peter	NULL	Smith	NULL	Personal	1	Peter Smith	245.25	1
2	James	NULL	Jones	JJ Enterprises	Company	2	JJ ENt.	552.39	2
2	James	NULL	Jones	JJ Enterprises	Company	3	JJ ENt. Mgr	10.25	2

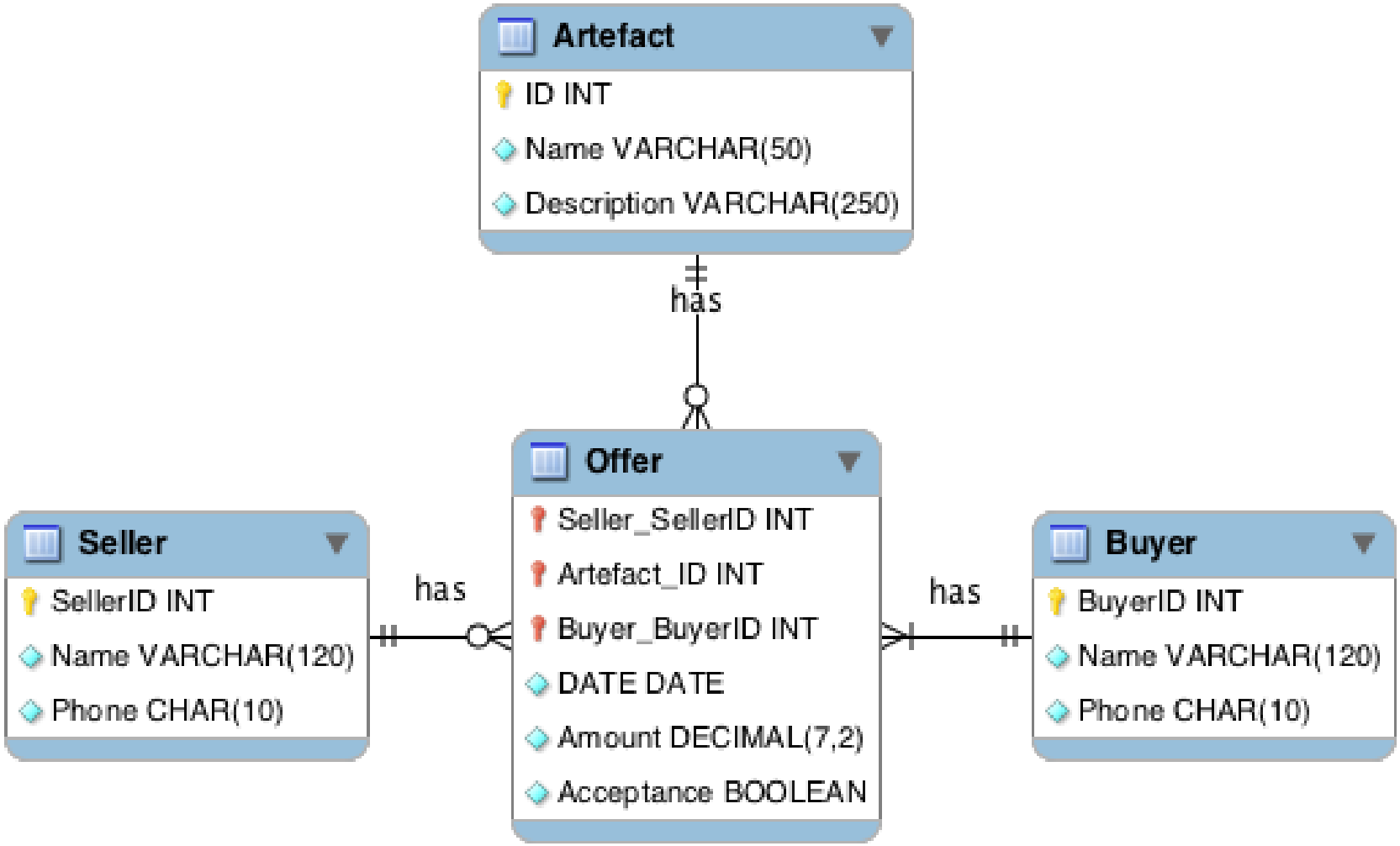
SQL – Query Nesting

- SQL provides the ability to Nest subqueries
  - Think nested “loops” or nested “ifs” in terms of programming
- A nested query is simply another select query you write to produce a table set
  - Remember that all select queries return a table set of data
- A common use of subqueries is to perform tests
  - Set membership, set comparisons

Sub-Query Comparison Operators

- IN / NOT IN
  - Use to test where the sub query returns multiple rows
- ANY
  - True if any value returned meets the condition
- ALL
  - True if all values returned meet the condition

Auction Bids – Physical Model



Relations

Artefact

ID	Name	Description
1	Vase	Old Vase
2	Knife	Old Knife
3	Pot	Old Pot

Seller

SellerID	Name	Phone
1	Abby	0233232232
2	Ben	0311111111
3	Carl	0333333333

Buyer

BuyerID	Name	Phone
1	Maggie	0333333333
2	Nicole	0444444444
3	Oleg	0555555555

Offer

SellerID	ArtefactID	BuyerID	Date	Amount	Acceptance
1	1	1	2012-06-20	81223.23	N
1	1	2	2012-06-20	82223.23	N
2	2	1	2012-06-20	19.95	N
2	2	2	2012-06-20	23.00	N

Example

- List the BuyerID, Name and Phone number for all bidders on artefact 1

```
SELECT * FROM Buyer
    WHERE BuyerID IN
        (SELECT BuyerID FROM Offer WHERE ArtefactID = 1)
```

BuyerID	Name	Phone
1	Maggie	0333333333
2	Nicole	0444444444

Some Queries Using Sets

- Which Artefacts don't have offers made on them

```
SELECT * FROM Artefact
    WHERE ID NOT IN
        (SELECT ArtefactID FROM Offer);
```

ID	Name	Description
3	Pot	Old Pot

- Which Buyers haven't made a bid for Artefact 3

```
SELECT * FROM Buyer
    WHERE BuyerID NOT IN
        (SELECT BuyerID FROM Offer
            WHERE ArtefactID = 3);
```

BuyerID	Name	Phone
1	Maggie	0333333333
2	Nicole	0444444444
3	Oleg	0555555555

You try …

Which Buyers haven't made a bid for the "Pot" Artefact ?

What's examinable

- You need to know how to write and think about SQL
  - DDL
  - DML

Next Lecture

- SQL Summary
  - Overview of concepts, more examples