



INFO20003 Database Systems

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Lecture 08
SQL

Semester 2 2018, Week 4



1. Find (the name of) all sailors whose rating is above 9
2. Find all sailors who reserved a boat prior to November 1, 1996
3. Find (the names of) all boats that have been reserved at least once
4. Find all pairs of sailors with the same rating

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- SQL – or SEQUEL is a language used in relational databases
- **DBMS support CRUD**
 - Create, Read, Update, Delete commands
- SQL supports **CRUD**
 - Create, Select, Update, Delete commands
- Other info **<https://powcoder.com>**
 - 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

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- Provides the following capabilities:
 - Data Definition Language (DDL)
 - To define and set up the database
 - CREATE, ALTER, DROP
 - Data Manipulation Language (DML)
 - To maintain and use the database
 - SELECT, INSERT, DELETE, UPDATE
 - Data Control Language (DCL)
 - To control access to the database
 - GRANT, REVOKE
 - Other Commands
 - Administer the database
 - Transaction Control
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- In **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 change data in the database

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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.

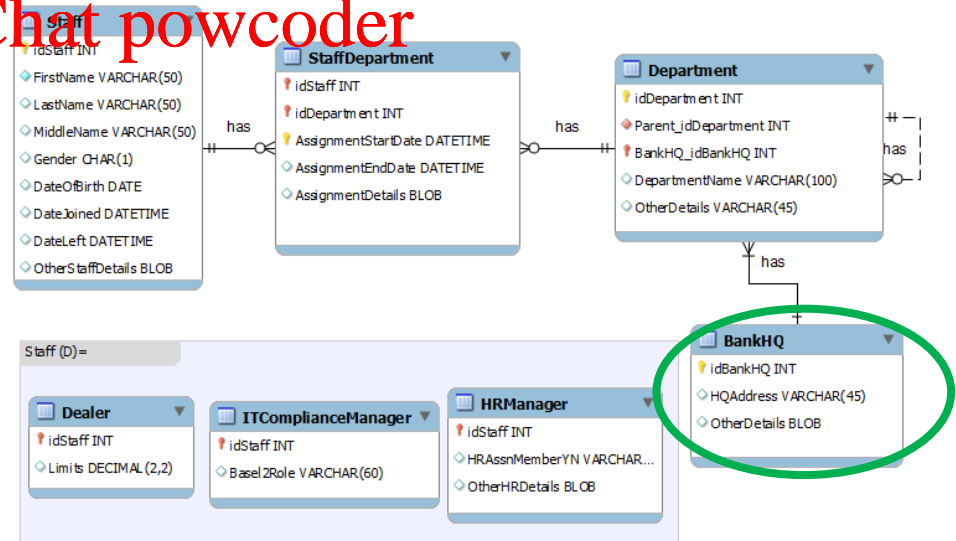
1 • `select * from BANKHQ`

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

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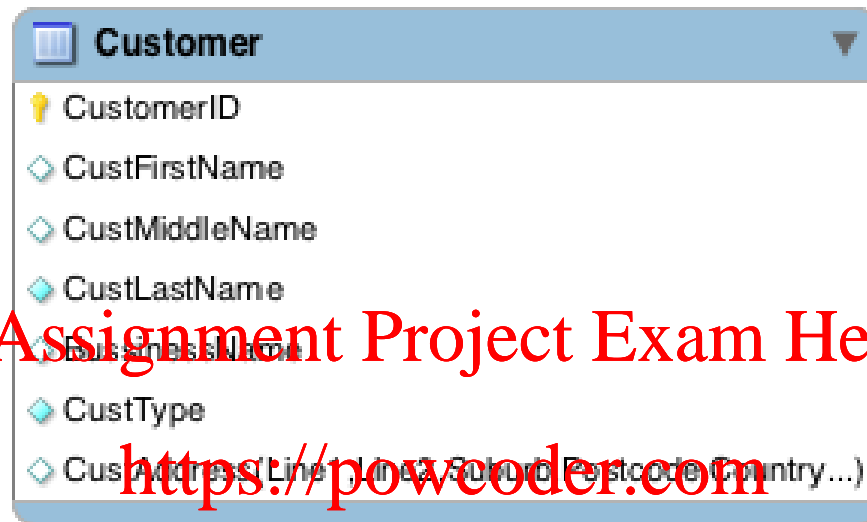
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Create Table: Review



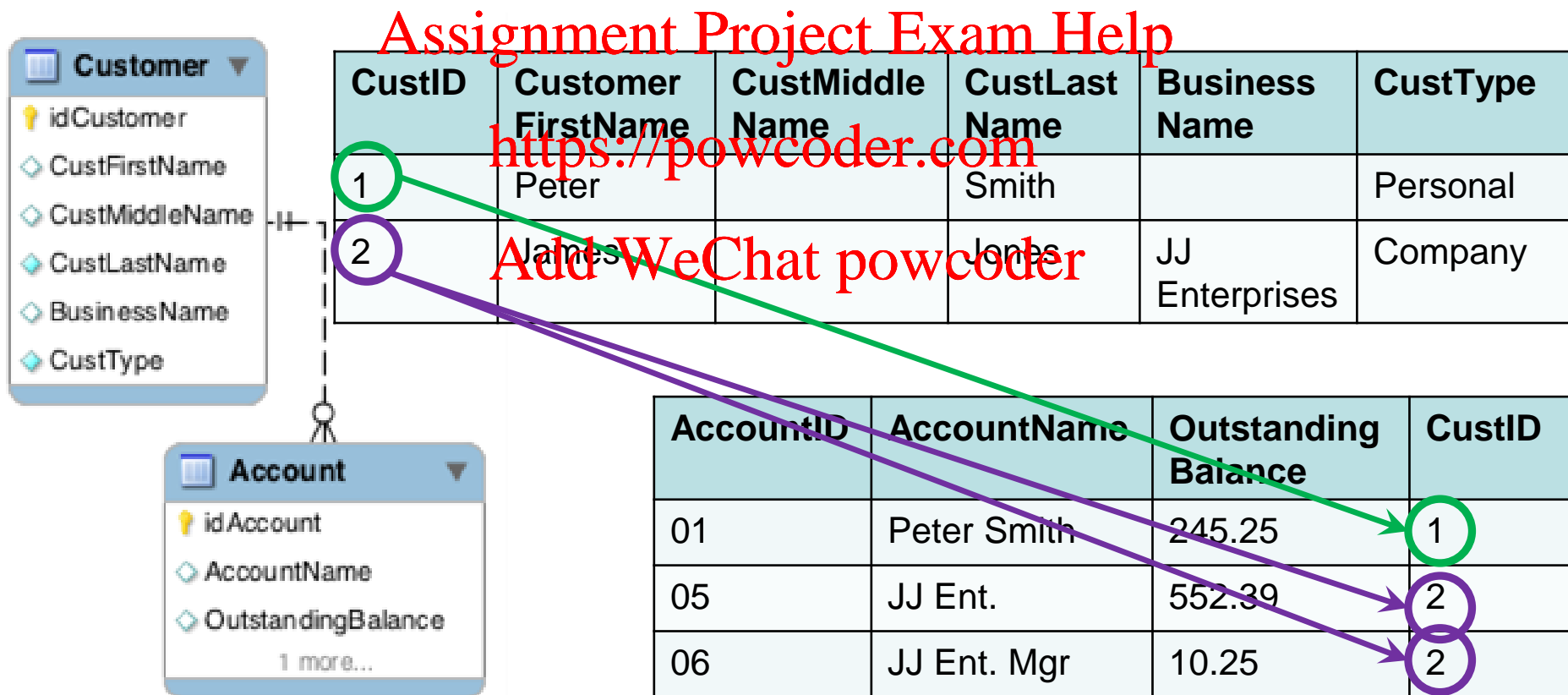
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```
CREATE TABLE Customer (  
  CustomerID          smallint          auto_increment,  
  CustFirstName       varchar(100),  
  CustMiddleName      varchar(100),  
  CustLastName        varchar(100)      NOT NULL,  
  BusinessName        varchar(200),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

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





```
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  
);
```

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1)

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

Specifies which columns
will be entered

2)

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

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No column specification means
ALL columns need to be entered

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

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Customer

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

What does **NULL** mean?

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Null Island: The Busiest Place That Doesn't Exist:
<https://www.youtube.com/watch?v=bjvlp1-1w84>
by the channel MinuteEarth

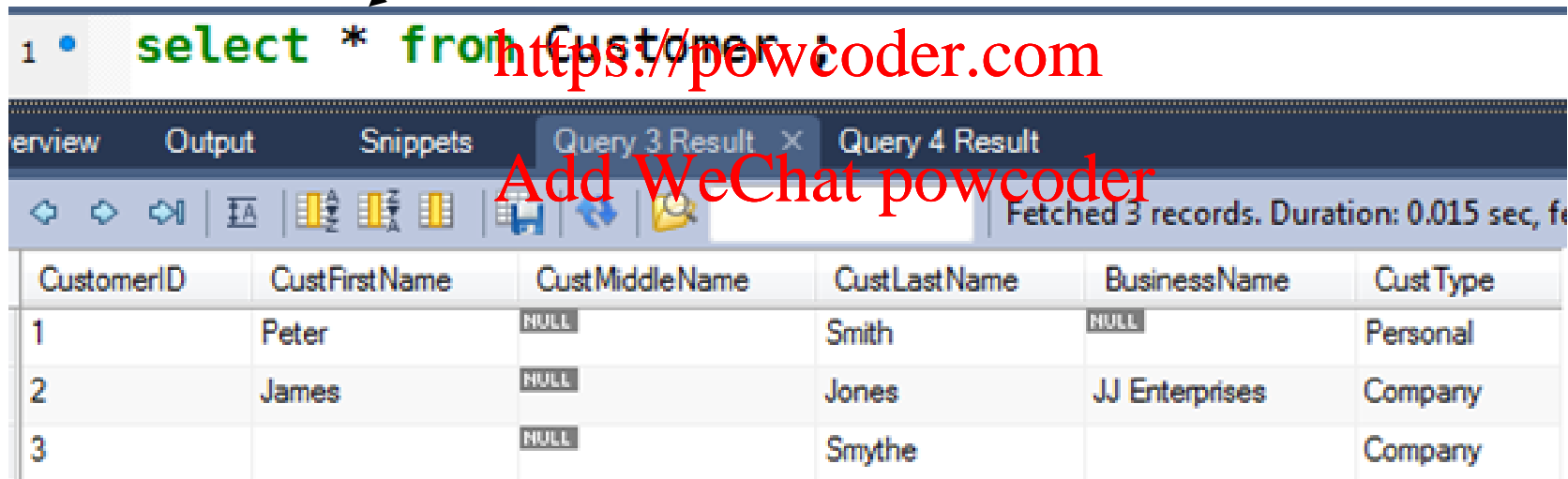


- Select statement allows us to query table(s)
 - * (star): Allows us to obtain *all* columns from a table

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```
1 • select * from Customer;
```

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



- 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)

Order is important! E.g. Limit cannot go before Group By or Having



Select Examples

Customer

- CustomerID INT
- CustomerFirstName VARCHAR(100)
- CustomerMiddleName VARCHAR(100)
- CustomerLastName VARCHAR(100)
- BusinessName VARCHAR(100)
- CustomerType CHAR(1)
- 5 more...

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

SQL

SELECT * FROM Customer;

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RESULT

CustomerID	CustFirst Name	CustMiddle Name	Cust LastName	BusinessName	Cust Type
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

Customer

CustomerID INT
CustomerFirstName VARCHAR(100)
CustomerMiddleName VARCHAR(100)
CustomerLastName VARCHAR(100)
BusinessName VARCHAR(100)
CustomerType CHAR(1)
5 more...

SQL

SELECT CustLastName **FROM** Customer;

Result

CustLastName
Smith
Jones
Smith
Smythe
Smart
Lam
Unila
Jones
Samson

In Relational Algebra:

$\pi_{CustLastName}(Customer)$

In SQL:

SELECT CustLastName
FROM Customer;

NOTE: MySQL doesn't discard duplicates.
To remove them use DISTINCT in front of
the projection list.

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In Relational Algebra:

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

In Relational Algebra:

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

In SQL:

WHERE cond1 AND cond2
OR cond3

In SQL:

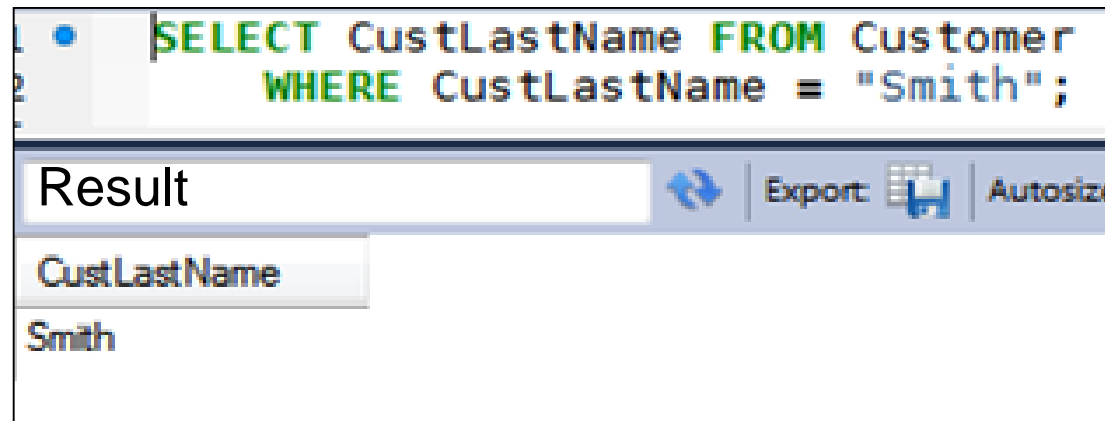
SELECT CustLastName
FROM Customer
WHERE CustLastName = "Smith";

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SQL





Select Examples: LIKE clause

- In addition to arithmetic expressions, string conditions are specified with the LIKE clause

LIKE "REG_EXP"

% Represents zero, one, or multiple characters

_ Represents a single character

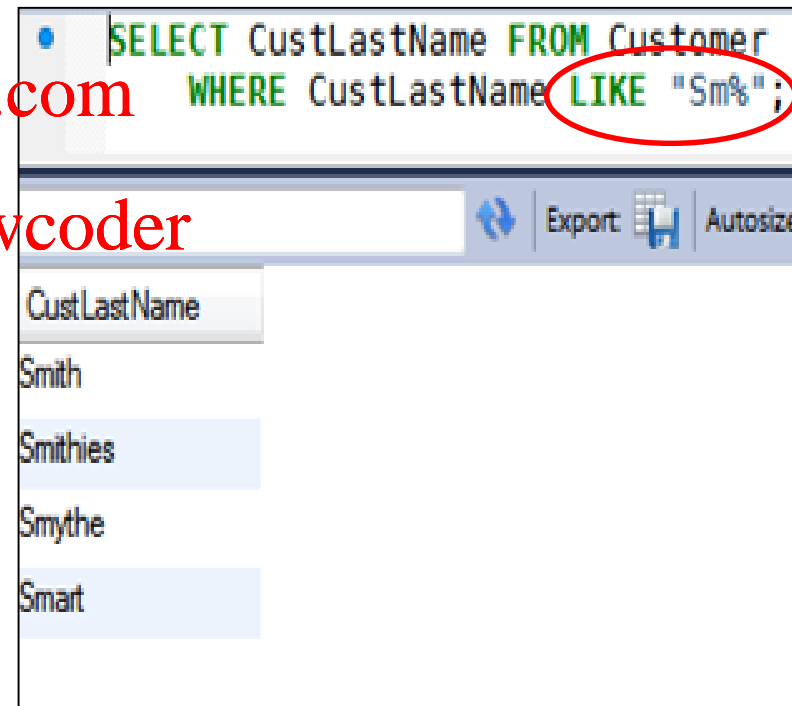
Examples:

WHERE CustomerName LIKE 'a%'	Finds any values that start with "a"
WHERE CustomerName LIKE '%a'	Finds any values that end 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 start with "a" and are at least 3 characters in length
WHERE ContactName LIKE 'a%o'	Finds any values that start with "a" and end with "o"

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Aggregate functions operate on the (sub)set 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

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- 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.



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

Examples:

SELECT COUNT(CustomerID)
FROM Customer;

= How many customers do we have
(currently)

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

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- **Group by** groups all records together over a set of attributes
- Frequently used with aggregate functions
- **Example:**

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

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

```
GROUP BY CustomerID;
```

- The only way to put a selection condition over a group by statement is by using **having** clause

- **Example:**

What is the exact average balance per customer for customers whose average balance is over 10000

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

```
GROUP BY CustomerID
```

```
HAVING AVG(OutstandingBalance) > 10000
```

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Column renaming

We can rename the column name of the output by using the AS clause

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

CustType	Count(CustomerID)
Personal	3
Company	6

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

CustType	Count
Personal	3
Company	6



- Orders records by particular column(s)

ORDER BY XXX ASC/DESC (ASC is default)

SQL

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

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

RESULT

CustLastName	Cust Type
Jones	Company
Jones	Company
Lam	Personal
Samson	Personal
Smart	Company
Smith	Personal
Smithies	Company
Smythe	Company
Unila	Company

CustLastName	Cust Type
Unila	Company
Smythe	Company
Smithies	Company
Smith	Personal
Smart	Company
Samson	Personal
Lam	Personal
Jones	Company
Jones	Company

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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;
```

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

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

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

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- SELECT * FROM **Rel1, Rel2**; - this is a **cross product**

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

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

Not quite useful...

Typically we would like to find:

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



Joins: Different Types

- **Inner/Equi join:**
 - Joins the tables over keys

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

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:**
 - Joins the tables over keys. The condition does not have to be specified (natural join does it automatically), but key attributes have to have the *same name*.

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

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



- **Outer join:**
 - Joins the tables over keys
 - Can be *left* or *right* (see difference below)
 - Includes records that **don't match** the join from the other table

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

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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
3	Akin	NULL	Smithies	Bay Wart	Company	NULL	NULL	NULL	NULL

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

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



- You need to know how to write SQL
 - DDL
 - DML

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- SQL Summary
 - Overview of concepts, more examples

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