SIT103/SIT772 Database Fundamentals

Week 5

Structured Query Language (SQL)

Dr Iynkaran Natgunanathan,

email: iynkaran.natgunanathan@deakin.edu.au,
Phone: +61 3 924 68825.

Last Week

- Database Anomalies
  - Insertion Anomaly
  - Update Anomaly
  - Deletion Anomaly
- Functional Dependencies
- Normalisation
  - 1NF, 2NF, and 3NF
- Denormalisation

- A relation is in 1NF if and only if
  - There is no repeating group
  - Has the PK that determine all attributes
- A relation is in 2NF if and only if
  - It is in 1NF
  - There is no partial dependency
- A relation is in 3NF if and only if
  - It is in 2NF
  - There is no transitive dependency

Last Week's OnTrack Tasks

- Task 4.1P Database Normalisation

  - Dependency Diagram

  - 1NF, 2NF and 3NF

- Task 4.2C Miniproject Part-1 - Database Design and Normalisation

  - Database modelling for a business organisation of your choice

  - Opportunity to experience data modelling in real-world

Database Design (Week 1-4)

- Identifying/understanding data requirements for a system
- Creating conceptual model
  - Entities, Attributes, Relationships, Constraints
- Converting conceptual model into logical model
  - Implementing relationships (PK/FK and Associative Entities)
- Entity Relationship Diagram (ERD)
- Normalisation
  - Controlling data redundancies and ensuring consistency
  - Normalised ERD

Questions?

Any questions/comments so far

Assignment 1

Last week's content

Anything in general about the unit

This week

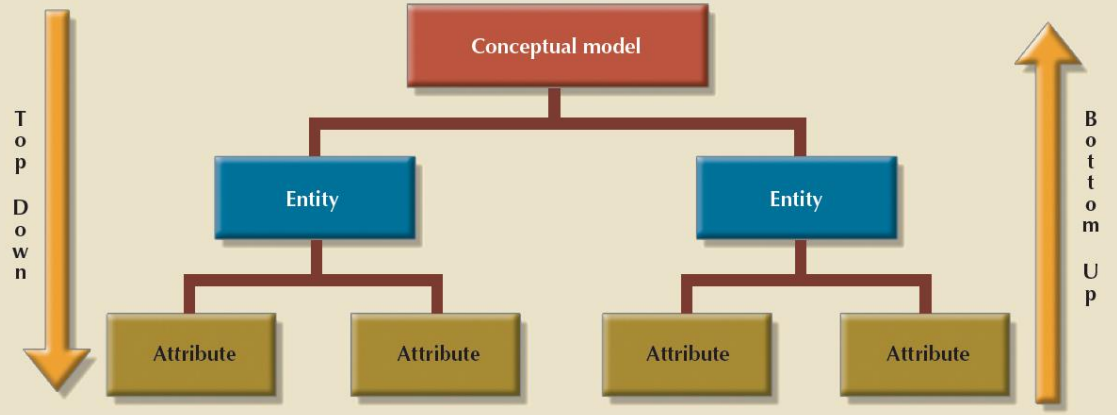
- Database design strategies
- DBMS software selection
- Introduction to SQL
- `SELECT` queries

    - to retrieve results from a single table

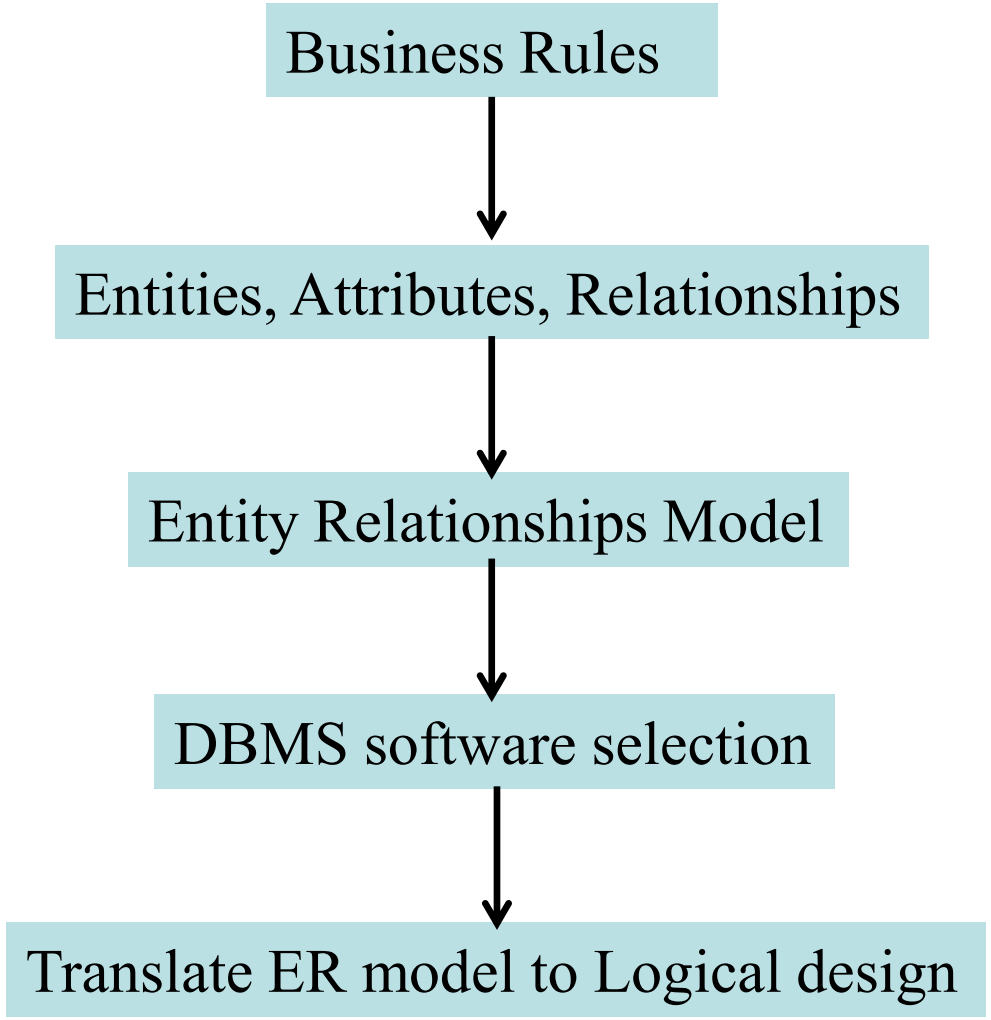
Database Design Strategies

- Top-down design starts by identifying the data sets and then defines the data elements for each of those sets
  - Involves the identification of different entity types and the definition of each entity's attributes
- Bottom-up design first identifies the data elements (items) and then groups them together in data sets
  - First defines attributes, and then groups them to form entities

FIGURE 9.14 TOP-DOWN VS. BOTTOM-UP DESIGN SEQUENCING



Conceptual design to Logical design



DBMS Software Selection

- Factors that affect the selection of DBMS software
  - Cost
  - Features and tools
  - Underlying model
  - Portability
  - DBMS hardware requirements

DBMS Software Selection (2)

- **Cost**
  - This includes the original purchase price, along with maintenance, operational, license, installation, training, and conversion costs.
- **Features and tools**
  - Some database software includes a variety of tools that facilitate application development.
  - For example, the availability of Query By Example (QBE), screen painters, report generators
  - Database administrator facilities, query facilities, ease of use, security, and third-party support also influence DBMS software selection.
- **Underlying model**
  - This can be relational, object/relational, or object-oriented or NoSQL.
- **Portability**
  - A DBMS can be portable across platforms, systems, and languages (e.g. SQLite)
- **Hardware requirements**
  - Items to consider include processor(s), RAM, disk space, and so on.

SQL-based relational database application

- SQL-based relational database application involves three parts

End-user interface

- Allows end user to interact with the data
- You can also design your own customized interface with the help of application generators that are now standard fare in the database software arena.

Collection of tables stored in the database

- All data are stored in the table
- Each table is independent from another
- Rows in different tables are related based on common values in common attributes

SQL engine

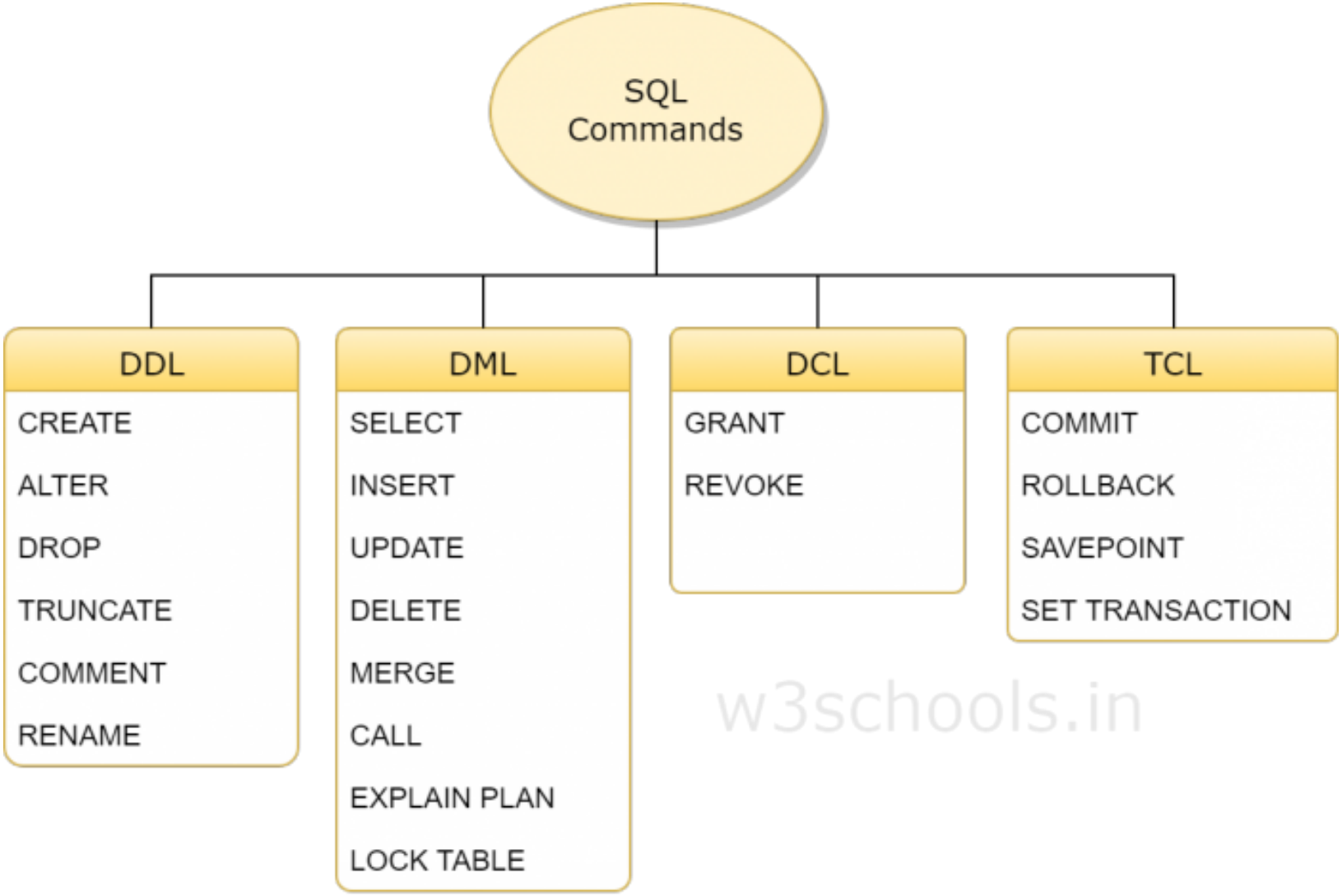
- Executes all queries
- SQL engine is part of the DBMS software
- The SQL engine processes all user requests—largely behind the scenes and without the end user's knowledge

Introduction to SQL

- A language used to implement and interact with DBs
- Non-procedural language with less than 100 commands

  user has to specify only "**what to do**" and **not "how to do"**
- Many SQL dialects exist – differences are minor
- Commands fall into two main categories
  1. **DDL** (Data Definition Language) commands
  2. **DML** (Data Manipulation Language) commands
  3. TCL (Transaction Control Language) commands
  4. DCL (Data Control Language) commands

SQL Commands



https://www.w3schools.in/mysql/ddl-dml-dcl

DML

DML Commands, Options, Operators

COMMAND, OPTION, OR OPERATOR	DESCRIPTION
SELECT	**Selects attributes from rows in one or more tables or views**
FROM	Specifies the tables from which data should be retrieved
WHERE	Restricts the selection of rows based on a conditional expression
GROUP BY	Groups the selected rows based on one or more attributes
HAVING	Restricts the selection of grouped rows based on a condition
ORDER BY	Orders the selected rows based on one or more attributes
INSERT	**Inserts row(s) into a table**
UPDATE	**Modifies an attribute's values in one or more table's rows**
DELETE	**Deletes one or more rows from a table**
Comparison operators	
=, <, >, <=, >=, <>, !=	Used in conditional expressions
Logical operators	
AND/OR/NOT	Used in conditional expressions
Special operators	**Used in conditional expressions**
BETWEEN	Checks whether an attribute value is within a range
IN	Checks whether an attribute value matches any value within a value list
LIKE	Checks whether an attribute value matches a given string pattern
IS NULL	Checks whether an attribute value is null
EXISTS	Checks whether a subquery returns any rows
DISTINCT	Limits values to unique values
Aggregate functions	**Used with SELECT to return mathematical summaries on columns**
COUNT	Returns the number of rows with non-null values for a given column
MIN	Returns the minimum attribute value found in a given column
MAX	Returns the maximum attribute value found in a given column
SUM	Returns the sum of all values for a given column
AVG	Returns the average of all values for a given column

DDL Commands and Options

COMMAND OR OPTION	DESCRIPTION
CREATE SCHEMA AUTHORIZATION	**Creates a database schema**
CREATE TABLE	**Creates a new table in the user's database schema**
NOT NULL	Ensures that a column will not have null values
UNIQUE	Ensures that a column will not have duplicate values
PRIMARY KEY	Defines a primary key for a table
FOREIGN KEY	Defines a foreign key for a table
DEFAULT	Defines a default value for a column (when no value is given)
CHECK	Validates data in an attribute
CREATE INDEX	**Creates an index for a table**
CREATE VIEW	**Creates a dynamic subset of rows and columns from one or more tables**
ALTER TABLE	**Modifies a table's definition (adds, modifies, or deletes attributes or constraints)**
CREATE TABLE AS	**Creates a new table based on a query in the user's database schema**
DROP TABLE	**Permanently deletes a table (and its data)**
DROP INDEX	**Permanently deletes an index**
DROP VIEW	**Permanently deletes a view**

TCL and DCL Commands

COMMAND OR OPTION	DESCRIPTION
Transaction Control Language	
COMMIT	Permanently saves data changes
ROLLBACK	Restores data to its original values
Data Control Language	
GRANT	Gives a user permission to take a system action or access a data object
REVOKE	Removes a previously granted permission from a user

Data type

- Specification about the kinds of data that can be stored in an attribute
  - Influence queries that retrieve data
- Fundamental types of data
  - Character data
  - Numeric data
  - Date data
- Other several types of data

Built-in Data types

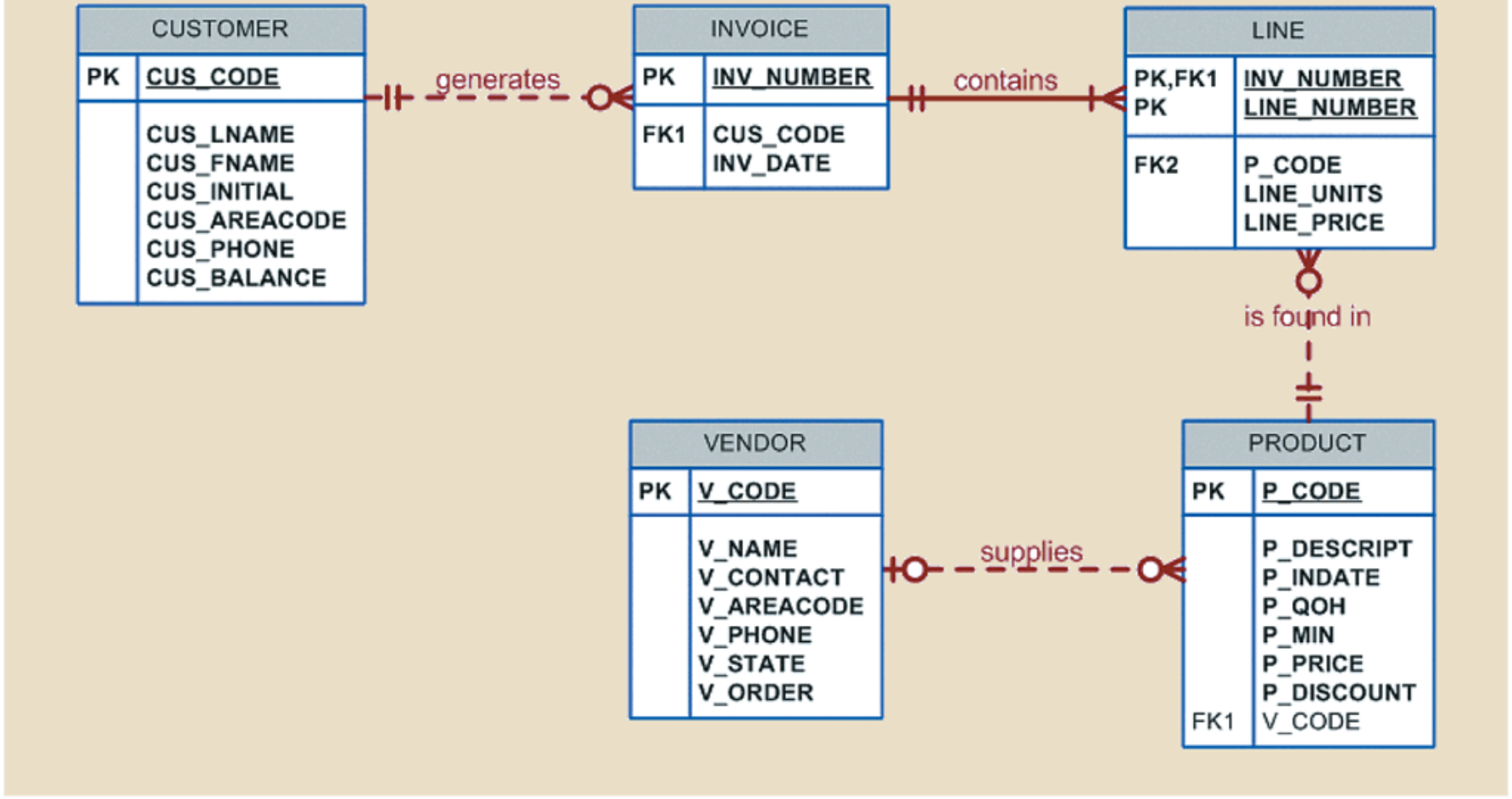
You don't have to know all of them, we need just a few widely used ones, *e.g.*, NUMERIC, INTEGER, CHAR, VARCHAR, BOOLEAN, DATE

MySQL Data Type	Oracle Data Type
TINYINT	NUMBER(3, 0)
SMALLINT	NUMBER(5, 0)
MEDIUMINT	NUMBER(7, 0)
INT	NUMBER(10, 0)
INTEGER	NUMBER(10, 0)
BIGINT	NUMBER(19, 0)
FLOAT	FLOAT
DOUBLE	FLOAT (24)
DOULBE PRECISION	FLOAT (24)
REAL	FLOAT (24)
DECIMAL	FLOAT (24)
NUMERIC	NUMBER
DATE	DATE
DATETIME	DATE
TIMESTAMP	NUMBER
TIME	DATE
YEAR	NUMBER
CHAR	CHAR
VARCHAR	VARCHAR2
TINYBLOB	RAW
TINYTEXT	VARCHAR2
BLOB	BLOB, RAW
TEXT	VARCHAR2, CLOB
MEDIUMBLOB	BLOB, RAW
MEDIUMTEXT	RAW, CLOB
LONGBLOB	BLOB, RAW
LONGTEXT	RAW, CLOB
ENUM	VARCHAR2, set to 100 by default
SET	VARCHAR2, set to 100 by default

https://www.w3schools.com/sql/sql_datatypes.asp
https://dev.mysql.com/doc/refman/8.0/en/data-types.html
https://docs.oracle.com/cd/B10501_01/win.920/a97249/ch3.htm#1026907

Sample Database Model

FIGURE 7.1 THE DATABASE MODEL



DML: Basic SELECT Queries

- To retrieve data from table(s)
- Basic syntax: `SELECT` *columnlist* `FROM` *tablelist*;
- Each clause in a `SELECT` query performs a specific function
  - `SELECT`: specifies the attributes to be returned by the query
  - `FROM`: specifies the table(s) from which the data will be retrieved
  - `WHERE`: filters the rows of data based on provided criteria
  - `GROUP BY`: groups the rows of data into collections based on sharing the same values in one or more attributes
  - `HAVING`: filters the groups formed in the GROUP BY clause based on provided criteria
  - `ORDER BY`: sorts the final query result rows in ascending or descending order based on the values of one or more attributes

SELECT : Get all columns

- Wildcard character "*"
  - to list all columns

SELECT *columnlist* FROM *tablelist*;

```
SELECT * FROM PRODUCT;
```

FIGURE 7.2 SELECT AN ENTIRE TABLE

P_CODE	P_DESCRIPT	P_INDATE	P_QOH	P_MIN	P_PRICE	P_DISCOUNT	V_CODE
11QER/31	Power painter, 15 psi., 3-nozzle	03-Nov-17	8	5	109.99	0.00	25595
13-Q2/P2	7.25-in. pwr. saw blade	13-Dec-17	32	15	14.99	0.05	21344
14-Q1/L3	9.00-in. pwr. saw blade	13-Nov-17	18	12	17.49	0.00	21344
1546-QQ2	Hrd. cloth, 1/4-in., 2x50	15-Jan-18	15	8	39.95	0.00	23119
1558-QW1	Hrd. cloth, 1/2-in., 3x50	15-Jan-18	23	5	43.99	0.00	23119
2232/QTY	B&D jigsaw, 12-in. blade	30-Dec-17	8	5	109.92	0.05	24288
2232/QWE	B&D jigsaw, 8-in. blade	24-Dec-17	6	5	99.87	0.05	24288
2238/QPD	B&D cordless drill, 1/2-in.	20-Jan-18	12	5	38.95	0.05	25595
23109-HB	Claw hammer	20-Jan-18	23	10	9.95	0.10	21225
23114-AA	Sledge hammer, 12 lb.	02-Jan-18	8	5	14.40	0.05	
54778-2T	Rat-tail file, 1/8-in. fine	15-Dec-17	43	20	4.99	0.00	21344
89-WRE-Q	Hicut chain saw, 16 in.	07-Feb-18	11	5	256.99	0.05	24288
PVC23DRT	PVC pipe, 3.5-in., 8-ft	20-Feb-18	188	75	5.87	0.00	
SM-18277	1.25-in. metal screw, 25	01-Mar-18	172	75	6.99	0.00	21225
SW-23116	2.5-in. wd. screw, 50	24-Feb-18	237	100	8.45	0.00	21231
WR3/TT3	Steel matting, 4'x8'x1/6", .5" mesh	17-Jan-18	18	5	119.95	0.10	25595

SELECT : Get some columns

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```
SELECT columnlist FROM tablelist;
```

```
SELECT P_CODE, P_DESCRIPT, P_PRICE, P_QOH FROM PRODUCT;
```

FIGURE 7.3 SELECT WITH A COLUMN LIST

P_CODE	P_DESCRIPT	P_PRICE	P_QOH
11QER/31	Power painter, 15 psi., 3-nozzle	109.99	8
13-Q2/P2	7.25-in. pwr. saw blade	14.99	32
14-Q1/L3	9.00-in. pwr. saw blade	17.49	18
1546-QQ2	Hrd. cloth, 1/4-in., 2x50	39.95	15
1558-QVV1	Hrd. cloth, 1/2-in., 3x50	43.99	23
2232/QTY	B&D jigsaw, 12-in. blade	109.92	8
2232/QWE	B&D jigsaw, 8-in. blade	99.87	6
2238/QPD	B&D cordless drill, 1/2-in.	38.95	12
23109-HB	Claw hammer	9.95	23
23114-AA	Sledge hammer, 12 lb.	14.40	8
54778-2T	Rat-tail file, 1/8-in. fine	4.99	43
89-WRE-Q	Hicut chain saw, 16 in.	256.99	11
PVC23DRT	PVC pipe, 3.5-in., 8-ft	5.87	188
SM-18277	1.25-in. metal screw, 25	6.99	172
SW-23116	2.5-in. wd. screw, 50	8.45	237
WR3/TT3	Steel matting, 4'x8'x1/6", .5" mesh	119.95	18

SELECT : Column aliases

- Keyword: AS

```
SELECT P_CODE, P_DESCRIPT AS DESCRIPTION, P_PRICE
AS "Unit Price", P_QOH AS QTY FROM PRODUCT;
```

Please note:

- DESCRIPTION vs "Unit Price"
- Not all columns have to aliased
- AS is optional

FIGURE 7.4 SELECT WITH COLUMN ALIASES

P_CODE	DESCRIPTION	Unit Price	QTY
11QER/31	Power painter, 15 psi., 3-nozzle	109.99	8
13-Q2/P2	7.25-in. pwr. saw blade	14.99	32
14-Q1/L3	9.00-in. pwr. saw blade	17.49	18
1546-QQ2	Hrd. cloth, 1/4-in., 2x50	39.95	15
1558-QVV1	Hrd. cloth, 1/2-in., 3x50	43.99	23
2232/QTY	B&D jigsaw, 12-in. blade	109.92	8
2232/QWE	B&D jigsaw, 8-in. blade	99.87	6
2238/QPD	B&D cordless drill, 1/2-in.	38.95	12
23109-HB	Claw hammer	9.95	23
23114-AA	Sledge hammer, 12 lb.	14.40	8
54778-2T	Rat-tail file, 1/8-in. fine	4.99	43
89-WRE-Q	Hicut chain saw, 16 in.	256.99	11
PVC23DRT	PVC pipe, 3.5-in., 8-ft	5.87	188
SM-18277	1.25-in. metal screw, 25	6.99	172
SW-23116	2.5-in. wd. screw, 50	8.45	237
WR3/TT3	Steel matting, 4'x8'x1/6", .5" mesh	119.95	18

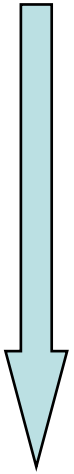
Arithmetic Operators

OPERATOR	DESCRIPTION
+	Add
-	Subtract
*	Multiply
/	Divide
^	Raise to the power of (some applications use ** instead of ^)

Precedence Rule

- Perform parentheses/brackets
- Perform power
- Perform multiplications and divisions
- Perform additions and subtractions

Higher precedence



Lower precedence

SELECT: Computed columns

```
SELECT  P_DESCRIPT, P_QOH, P_PRICE, P_QOH * P_PRICE AS TOTALVALUE
FROM  PRODUCT;
```

"*" is used for multiplication not as a wildcard

P_DESCRIPT	P_QOH	P_PRICE	TOTVALUE
Power painter, 15 psi., 3-nozzle	8	109.99	879.92
7.25-in. pwr. saw blade	32	14.99	479.68
9.00-in. pwr. saw blade	18	17.49	314.82
Hrd. cloth, 1/4-in., 2x50	15	39.95	599.25
Hrd. cloth, 1/2-in., 3x50	23	43.99	1011.77
B&D jigsaw, 12-in. blade	8	109.92	879.36
B&D jigsaw, 8-in. blade	6	99.87	599.22
B&D cordless drill, 1/2-in.	12	38.95	467.40
Claw hammer	23	9.95	228.85
Sledge hammer, 12 lb.	8	14.40	115.20
Rat-tail file, 1/8-in. fine	43	4.99	214.57
Hicut chain saw, 16 in.	11	256.99	2826.89
PVC pipe, 3.5-in., 8-ft	188	5.87	1103.56
1.25-in. metal screw, 25	172	6.99	1202.28
2.5-in. wd. screw, 50	237	8.45	2002.65
Steel matting, 4'x8'x1/6", .5" mesh	18	119.95	2159.10

DISTINCT: Unique values

- Gets a list of attribute values different from each other – No duplicates

```
SELECT V_CODE FROM PRODUCT;
```

V_CODE
25595
21344
21344
23119
23119
24288
24288
25595
21225
21344
24288
21225
21231
25595

```
SELECT DISTINCT V_CODE FROM PRODUCT;
```

V_CODE
21225
21231
21344
23119
24288
25595

ORDER BY

- Sorting record in ascending or descending order
- Syntax: `SELECT` *columnlist* `FROM` *tablelist* `[ORDER BY` *columnlist* `[ASC|DESC]];`
- Default: `[ASC]`

```
SELECT P_CODE, P_DESCRIPT, P_QOH, P_PRICE
FROM PRODUCT ORDER BY P_PRICE [ASC];
```

ASC is optional

P_CODE	P_DESCRIPT	P_QOH	P_PRICE
54778-2T	Rat-tail file, 1/8-in. fine	43	4.99
PVC23DRT	PVC pipe, 3.5-in., 8-ft	188	5.87
SM-18277	1.25-in. metal screw, 25	172	6.99
SW-23116	2.5-in. wd. screw, 50	237	8.45
23109-HB	Claw hammer	23	9.95
23114-AA	Sledge hammer, 12 lb.	8	14.40
13-Q2/P2	7.25-in. pwr. saw blade	32	14.99
14-Q1/L3	9.00-in. pwr. saw blade	18	17.49
2238/QPD	B&D cordless drill, 1/2-in.	12	38.95
1546-QQ2	Hrd. cloth, 1/4-in., 2x50	15	39.95
1558-QVV1	Hrd. cloth, 1/2-in., 3x50	23	43.99
2232/QWE	B&D jigsaw, 8-in. blade	6	99.87
2232/QTY	B&D jigsaw, 12-in. blade	8	109.92
11QER/31	Power painter, 15 psi., 3-nozzle	8	109.99
WR3/TT3	Steel matting, 4'x8'x1/6", .5" mesh	18	119.95
89-WRE-Q	Hicut chain saw, 16 in.	11	256.99

Sort in descending order

```
SELECT P_CODE, P_DESCRIPT,
P_QOH, P_PRICE FROM PRODUCT
ORDER BY P_PRICE DESC;
```

DESC is required

Cascading order sequence

```
SELECT EMP_LNAME, EMP_FNAME, EMP_INITIAL, EMP_AREACODE, EMP_PHONE
FROM EMPLOYEE ORDER BY  EMP_LNAME, EMP_FNAME, EMP_INITIAL;
```

EMP_LNAME	EMP_FNAME	EMP_INITIAL	EMP_AREACODE	EMP_PHONE
Brandon	Marie	G	901	882-0845
Diante	Jorge	D	615	890-4567
Genkazi	Leighla	W	901	569-0093
Johnson	Edward	E	615	898-4387
Jones	Anne	M	615	898-3456
Kolmycz	George	D	615	324-5456
Lange	John	P	901	504-4430
Lewis	Rhonda	G	615	324-4472
Saranda	Hermine	R	615	324-5505
Smith	George	A	615	890-2984
Smith	George	K	901	504-3339
Smith	Jeanine	K	615	324-7883
Smythe	Melanie	P	615	324-9006
Vandam	Rhett		901	675-8993
Washington	Rupert	E	615	890-4925
Wiesenbach	Paul	R	615	897-4358
Williams	Robert	D	615	890-3220

Cascading order sequence (1)

```
SELECT P_CODE, P_DESCRIPT, V_CODE, P_PRICE * P_QOH AS TOTAL FROM
PRODUCT ORDER BY  V_CODE, TOTAL DESC;
```

P_CODE	P_DESCRIPT	V_CODE	TOTAL
PVC23DRT	PVC pipe, 3.5-in., 8-ft		1103.56
23114-AA	Sledge hammer, 12 lb.		115.20
SM-18277	1.25-in. metal screw, 25	21225	1202.28
23109-HB	Claw hammer	21225	228.85
SW-23116	2.5-in. wd. screw, 50	21231	2002.65
13-Q2/P2	7.25-in. pwr. saw blade	21344	479.68
14-Q1/L3	9.00-in. pwr. saw blade	21344	314.82
54778-2T	Rat-tail file, 1/8-in. fine	21344	214.57
1558-QWV1	Hrd. cloth, 1/2-in., 3x50	23119	1011.77
1546-QQ2	Hrd. cloth, 1/4-in., 2x50	23119	599.25
89-WRE-Q	Hicut chain saw, 16 in.	24288	2826.89
2232/QTY	B&D jigsaw, 12-in. blade	24288	879.36
2232/QWE	B&D jigsaw, 8-in. blade	24288	599.22
WR3/TT3	Steel matting, 4'x8'x1/6", .5" mesh	25595	2159.10
11QER/31	Power painter, 15 psi., 3-nozzle	25595	879.92
2238/QPD	B&D cordless drill, 1/2-in.	25595	467.40

Ascending order of V_CODE and descending order of TOTAL (computed column, not in the table) within the same code

WHERE Clause: Selecting rows

- Selecting rows with conditional restrictions
- Syntax :

```
SELECT columnlist FROM tablelist [WHERE conditionlist] [ORDER BY columnlist [ASC|DESC]];
```

- Using comparison or logical operators

Comparison operators

SYMBOL	MEANING
=	Equal to
<	Less than
<=	Less than or equal to
>	Greater than
>=	Greater than or equal to
<> or !=	Not equal to

Logical operators

AND, OR and NOT

Special operators

BETWEEN, IN, LIKE, and IS NULL

Comparison Operators - Numbers

```
SELECT P_DESCRIPT, P_QOH, P_PRICE, V_CODE
FROM PRODUCT WHERE  V_CODE = 21344;
```

P_DESCRIPT	P_QOH	P_PRICE	V_CODE
7.25-in. pwr. saw blade	32	14.99	21344
9.00-in. pwr. saw blade	18	17.49	21344
Rat-tail file, 1/8-in. fine	43	4.99	21344

```
SELECT P_DESCRIPT, P_QOH, P_PRICE, V_CODE
FROM PRODUCT WHERE  V_CODE <> 21344;
```

P_DESCRIPT	P_QOH	P_PRICE	V_CODE
Power painter, 15 psi., 3-nozzle	8	109.99	25595
Hrd. cloth, 1/4-in., 2x50	15	39.95	23119
Hrd. cloth, 1/2-in., 3x50	23	43.99	23119
B&D jigsaw, 12-in. blade	8	109.92	24288
B&D jigsaw, 8-in. blade	6	99.87	24288
B&D cordless drill, 1/2-in.	12	38.95	25595
Claw hammer	23	9.95	21225
Hicut chain saw, 16 in.	11	256.99	24288
1.25-in. metal screw, 25	172	6.99	21225
2.5-in. wd. screw, 50	237	8.45	21231
Steel matting, 4'x8'x1/6", .5" mesh	18	119.95	25595

```
SELECT P_DESCRIPT, P_QOH, P_MIN,
P_PRICE FROM PRODUCT WHERE
P_PRICE <= 10;
```

P_DESCRIPT	P_QOH	P_MIN	P_PRICE
Claw hammer	23	10	9.95
Rat-tail file, 1/8-in. fine	43	20	4.99
PVC pipe, 3.5-in., 8-ft	188	75	5.87
1.25-in. metal screw, 25	172	75	6.99
2.5-in. wd. screw, 50	237	100	8.45

Comparison Operators - Characters

- Strings (characters-based data) comparison based on their numeric **ASCII** (American Standard Code for Information Interchange) **codes**

```
SELECT P_CODE, P_DESCRIPT, P_QOH, P_MIN, P_PRICE FROM PRODUCT
WHERE  P_CODE < '1558-QW1';
```

P_CODE	P_DESCRIPT	P_QOH	P_MIN	P_PRICE
11QER/31	Power painter, 15 psi., 3-nozzle	8	5	109.99
13-Q2/P2	7.25-in. pwr. saw blade	32	15	14.99
14-Q1/L3	9.00-in. pwr. saw blade	18	12	17.49
1546-QQ2	Hrd. cloth, 1/4-in., 2x50	15	8	39.95

- Similarly,

```
SELECT P_CODE, P_DESCRIPT, P_QOH, P_MIN, P_PRICE FROM PRODUCT
WHERE  P_CODE = '1558-QW1';
```

```
SELECT P_CODE, P_DESCRIPT, P_QOH, P_MIN, P_PRICE FROM PRODUCT
WHERE  P_CODE != '1558-QW1';
```

LIKE and % and _ wildcards

- Used to find patterns in strings
- For substring matches
- % means any and all following or preceding characters are eligible
  - 'J%' includes Johnson, Jones, Jernigan, July, and J-231Q.
  - 'Jo%' includes Johnson and Jones.
  - '%n' includes Johnson and Jernigan.
- _ means any one character may be substituted for the underscore
  - '_23-456-6789' includes 123-456-6789, 223-456-6789, and 323-456-6789.
  - '_23-_56-678_' includes 123-156-6781, 123-256-6782, and 823-956-6788.
  - '_o_es' includes Jones, Cones, Cokes, totes, and roles.
- % can be used for prefix and suffix substitution: '%nar%' for binaries, unary
- _can be repeated for multiple characters match: '___teen' for fifteen, sixteen

String pattern matching

```
SELECT V_NAME, V_CONTACT, V_AREACODE, V_PHONE
FROM VENDOR WHERE V_CONTACT LIKE 'Smith%';
```

V_NAME	V_CONTACT	V_AREACODE	V_PHONE
Bryson, Inc.	Smithson	615	223-3234
Dome Supply	Smith	901	678-1419
B&K, Inc.	Smith	904	227-0093

```
SELECT V_NAME, V_CONTACT, V_AREACODE, V_PHONE
FROM VENDOR WHERE V_CONTACT LIKE 'SMITH%';
```

- Does not give the same results – CASE SENTITIVE

```
SELECT V_NAME, V_CONTACT, V_AREACODE, V_PHONE FROM
VENDOR WHERE UPPER(V_CONTACT) LIKE 'SMITH%';
```

- Can use `UPPER()` and `LOWER()` to cater for different cases

```
SELECT V_NAME, V_CONTACT, V_AREACODE, V_PHONE
FROM VENDOR WHERE V_CONTACT NOT LIKE 'Smith%';
```

- Returns records where V_CONTACT **does not start** with 'Smith'

```
SELECT V_NAME, V_CONTACT, V_AREACODE, V_PHONE FROM
VENDOR WHERE V_CONTACT LIKE 'Johns_n';
```

- Returns records where V_CONTACT is 'Johnson' or 'Johnsen' or 'Johnsin'

Comparison Operators - Date

```
SELECT P_DESCRIPT, P_QOH, P_MIN, P_PRICE, P_INDATE
FROM PRODUCT WHERE P_INDATE >= '20-Jan-2018';
```

Data comparison

P_DESCRIPT	P_QOH	P_MIN	P_PRICE	P_INDATE
B&D cordless drill, 1/2-in.	12	5	38.95	20-Jan-18
Claw hammer	23	10	9.95	20-Jan-18
Hicut chain saw, 16 in.	11	5	256.99	07-Feb-18
PVC pipe, 3.5-in., 8-ft	188	75	5.87	20-Feb-18
1.25-in. metal screw, 25	172	75	6.99	01-Mar-18
2.5-in. wd. screw, 50	237	100	8.45	24-Feb-18

- Products with stock date on or after January 20, 2018

Multiple Conditions – Logical Operators

- Filter records using multiple conditions
- Logical operators – AND, OR, and NOT

```
SELECT P_DESCRIPT, P_QOH, P_PRICE, V_CODE FROM
PRODUCT WHERE V_CODE = 21344 OR V_CODE = 24288;
```

P_DESCRIPT	P_QOH	P_PRICE	V_CODE
7.25-in. pwr. saw blade	32	14.99	21344
9.00-in. pwr. saw blade	18	17.49	21344
B&D jigsaw, 12-in. blade	8	109.92	24288
B&D jigsaw, 8-in. blade	6	99.87	24288
Rat-tail file, 1/8-in. fine	43	4.99	21344
Hicut chain saw, 16 in.	11	256.99	24288

```
SELECT P_DESCRIPT, P_QOH, P_PRICE, V_CODE FROM
PRODUCT WHERE P_PRICE > 100 AND P_QOH < 20;
```

P_DESCRIPT	P_QOH	P_PRICE	V_CODE
Power painter, 15 psi., 3-nozzle	8	109.99	25595
B&D jigsaw, 12-in. blade	8	109.92	24288
Hicut chain saw, 16 in.	11	256.99	24288
Steel matting, 4'x8'x1/6", .5" mesh	18	119.95	25595

```
SELECT P_DESCRIPT, P_PRICE, V_CODE FROM PRODUCT WHERE
(V_CODE = 25595 OR V_CODE = 24288) AND P_PRICE > 100;
```

P_DESCRIPT	P_PRICE	V_CODE
Power painter, 15 psi., 3-nozzle	109.99	25595
B&D jigsaw, 12-in. blade	109.92	24288
Hicut chain saw, 16 in.	256.99	24288
Steel matting, 4'x8'x1/6", .5" mesh	119.95	25595

```
SELECT * FROM PRODUCT WHERE NOT (V_CODE = 21344);
```


Above query is the same as: `SELECT * FROM PRODUCT WHERE V_CODE <> 21344;`

Special Operators

- BETWEEN: check whether attribute value is within a range
- IN: check whether an attribute matches any value in a list
- IS NULL: check whether an attribute value is NULL
- LIKE: check whether an attribute value matches a given string pattern

```
SELECT * FROM PRODUCT WHERE P_PRICE BETWEEN 50.00 AND 100.00;
```

```
SELECT * FROM PRODUCT WHERE P_PRICE >= 50.00 AND P_PRICE <=100.00;
```

```
SELECT * FROM PRODUCT WHERE V_CODE IN (21344, 24288);
```

```
SELECT * FROM PRODUCT WHERE V_CODE = 21344 OR V_CODE = 24288;
```

```
SELECT P_CODE, P_DESCRIPT, V_CODE FROM
PRODUCT WHERE V_CODE IS NULL;
```

P_CODE	P_DESCRIPT	V_CODE
23114-AA	Sledge hammer, 12 lb.	
PVC23DRT	PVC pipe, 3.5-in., 8-ft	

Aggregate Functions

- Get a summary of data
- Aggregate functions
  - `Count`
  - `MIN` and `MAX`
  - `SUM` and `AVG`

FUNCTION	OUTPUT
COUNT	The number of rows containing non-null values
MIN	The minimum attribute value encountered in a given column
MAX	The maximum attribute value encountered in a given column
SUM	The sum of all values for a given column
AVG	The arithmetic mean (average) for a specified column

Aggregate Function – count()

```
SELECT COUNT(P_CODE) FROM PRODUCT;
```

CountOfP_CODE
16

```
SELECT COUNT(P_PRICE) FROM PRODUCT WHERE P_PRICE < 10;
```

- Count of price more than 10

```
SELECT COUNT(DISTINCT V_CODE) AS "COUNT DISTINCT" FROM PRODUCT;
```

- Count of non-NULL distinct Vendors

Count Distinct
6

```
SELECT COUNT(*) FROM PRODUCT;
```

- Count of the number of records in the PRODUCT table

min(),max(),sum(),agv()

- To get smallest and largest attribute values

```
SELECT MAX(P_PRICE) AS MAXPRICE, MIN(P_PRICE) AS MINPRICE
FROM PRODUCT;
```

MAXPRICE	MINPRICE
256.99	4.99

```
SELECT SUM(CUS_BALANCE) AS TOTBALANCE FROM CUSTOMER;
```

- Gets the sum of customer balances

```
SELECT SUM(P_QOH * P_PRICE) AS TOTVALUE FROM PRODUCT;
```

- Gets the total value of the products' quantities on hand

TOTVALUE
15084.52

```
SELECT AVG(P_PRICE) AS AVGPRICE FROM PRODUCT;
```

- Gets the average price of products

GROUP BY Clause

- Grouping rows based on values of some attributes
- Aggregate function can be used to summarize each group

```
SELECT columnlist FROM tablelist [WHERE conditionlist] [GROUP
BY columnlist] [ORDER BY columnlist [ASC| DESC]];
```

```
SELECT V_CODE, AVG(P_PRICE)
AS AVGPRICE FROM PRODUCT
GROUP BY V_CODE;
```

V_CODE	AVGPRICE
	10.13
21225	8.47
21231	8.45
21344	12.49
23119	41.97
24288	155.59
25595	89.63

```
SELECT V_CODE, COUNT(P_CODE) AS
NUMPROD, AVG(P_PRICE) AS AVGPRICE
FROM PRODUCT GROUP BY V_CODE
ORDER BY V_CODE;
```

- Gets the number of products and their average price for each vendor

HAVING Clause

- Useful to restrict results after applying GROUP BY
- Selecting rows conditioned on group wise aggregation
- Can not be used with WHERE clause as GROUP BY is applied on the results after WHERE is executed

SELECT *columnlist* FROM *tablelist* [WHERE *conditionlist*] [GROUP BY *columnlist*] [HAVING *conditionlist*] [ORDER BY *columnlist* [ASC| DESC]];

```
SELECT V_CODE, COUNT(P_CODE) AS NUMPRODS
FROM PRODUCT GROUP BY V_CODE HAVING
AVG(P_PRICE) < 10 ORDER BY V_CODE;
```

V_CODE	NUMPRODS
21225	2
21231	1

Subqueries

- Filtering results based another set of processed data
  - retrieving information from multiple tables
  - filtering results based on the result of another query

```
SELECT V_CODE, V_NAME FROM VENDOR WHERE V_CODE NOT IN (SELECT
DISTINCT V_CODE FROM PRODUCT WHERE V_CODE IS NOT NULL);
```

- Gets a list of potential vendors who do not provide products yet

```
SELECT P_CODE, P_PRICE FROM PRODUCT WHERE P_PRICE >= (SELECT
AVG(P_PRICE) FROM PRODUCT);
```

- Lists products with price greater than or equal to the average product price

SQL Demo

Let's see some examples

Summary

- Introduction to SQL: DML, DDL, TCL, DCL
- DML – `SELECT` queries

  `FROM`, `WHERE`, `ORDER BY`, `GROUP BY`, `HAVING`, `AS`, `DISTINCT`,
- Arithmetic, Comparison, Logical and Special operators
- Wildcards
- Aggregate functions
- Subqueries – nested queries

This Week's OnTrack Tasks

- 5.1P Basic SQL

  - `SELECT` queries

- 5.2C Online Quiz 1

  - Do the online Quiz 1 in the CloudDeakin site

  - Submit the screenshot of the completion of the Quiz

  - Quiz is released and you have one week to complete.

  - You have three attempts to score 80% or more.

  - Once you start the Quiz, you will have 1 hours (60 mins) to complete

Next Week

- Relational Algebra and `JOIN`

Thank you

See you next week

Any questions/comments?

Readings and References:

- Chapters 9 and 7

Database Systems : Design, Implementation, & Management 13TH EDITION, by Carlos Coronel, Steven Morris