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Database Management II
Structured Query Language

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- Introduction
- Basic SQL Language Elements
- Advanced SQL Language Elements
- SQL-driven Database Features
- Issues of SQL
- SQL Tool: W3Schools

- **SQL - Structured Query Language**
 - Developed in the 1970s
 - Current standard for management of relational databases:
 - ANSI (American National Standards Institute)
 - ISO (International Standardization Organization),
 - Current version of framework: **ISO/IEC 9075-1:2016**
Information technology – Database languages – SQL – Part 1: Framework (SQL/Framework)
 - Non-procedural, descriptive and declarative language for the use of databases
 - With a SQL query, a user only expresses a desired result (and not the way how this result has to be generated).

- **Data Definition Language (DDL)**
 - Definition of data structures (e.g. tables, databases)
- **Data Manipulation Language (DML)**
 - Viewing, inserting, deleting and updating data in a database
- **Data Control Language (DCL)**
 - Access control for data in a database
- **Transaction Control Language (TCL)**
 - Control of transactional processing in a database
 - A transaction is a logical unit of multiple SQL statements.

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Data Definition Language: CREATE

```
CREATE TABLE table_name
(
  column_name1 data_type,
  column_name2 data_type,
  .....
)
```

Data types

Data Type	
integer(size)	Integer, "size" defines the maximum number of digits.
decimal(p,s)	p specifies the maximum total number of decimal digits that can be stored, both to the left and to the right of the decimal point. s specifies the number of decimal digits to the right of the decimal point.
char(size)	Fixed-length character data (length of "size")
varchar(size)	Variable-length character data (maximum length of "size")
date(yyymmdd)	Date [and time] with all four digits of the year, month, day, [hour (in 24-hour format), minute, and second], e.g. 20070115
...	

```
CREATE TABLE Product_Info
(
  Article_no integer(10),
  Weight decimal(2,2),
  Resolution varchar(9),
  Power_consumption integer(3)
)
```

NB: “decimal(2,2)” may not make much sense in the application case, but is syntax wise correct.

Table “Product_Info”

<u>ID</u>	Article_no	Weight	Resolution	Power_consumption

DROP Table Table_name

Deletes a specified table from the database.

DROP Database Database_name

Deletes all tables including the database itself on the database server.

Data Manipulation Language: Structure of Basic Elements

- Structure of the basic elements (clauses)
 - SELECT attribute(s)
 - FROM relation(s)
 - [WHERE condition(s)]
 - [GROUP BY attribute(s)]
 - [ORDER BY attribute(s)]

- Date Format, Strings and Numbers
 - Date Format: 'YYYY-MM-DD', e.g. '1974-12-31'
 - Strings: 'String', e.g. 'I like SQL'
 - Numbers: Number, e.g. 41 or 34.12

Note: (1) Dates and Strings have to be enclosed by two apostrophes.
 (2) The clauses in [...] are optional.

SELECT * ←————— *All columns*
FROM Products ←————— *table "Products"*
ORDER BY ID ←————— *order result by column "ID"*

ID	Product_name	Colour	Article_no	Sale_price	Purchase_price	Stock	Items_sold	City
1	Monitor 17"	White	1297812542	399.00	249.99	50	134	Frankfurt
2	Monitor 19"	black	2457897145	499.00	379.00	12	289	Berlin
3	Monitor 17"	black	1297467815	405.00	249.99	25	124	Frankfurt
4	Monitor 19"	white	2459871327	509.00	389.99	150	12	Frankfurt
5	Monitor 20"	black	2789441512	799.00	599.00	520	1052	Berlin
6	Monitor 20"	white	2799151424	829.00	549.99	100	26	Berlin
7	Monitor 20"	anthracite	2764657527	819.00	589.99	50	127	Nürnberg
8	Monitor 21"	anthracite	2845161215	999.00	799.99	100	279	Hamburg
9	Monitor 24"	white	2945712415	1299.00	945.00	25	124	Berlin
10	Monitor 24"	black	2955745742	1350.00	956.00	450	1024	Hamburg
...								

```
SELECT *
FROM Products
WHERE Purchase_price > 500 AND City = 'Berlin'
```

<u>ID</u>	Product_name	Colour	Article_no	Sale_price	Purchase_price	Stock	Sold_items	City
5	Monitor 20"	black	2789441512	799.00	599.00	520	1052	Berlin
6	Monitor 20"	white	2799151424	829.00	549.99	100	26	Berlin
9	Monitor 24"	white	2945712415	1299.00	945.00	25	124	Berlin

DML: SELECT using ORDER BY

SELECT ID, City, Stock
FROM Products
ORDER BY ID

<u>ID</u>	City	Stock
1	Frankfurt	50
2	Berlin	12
3	Frankfurt	25
4	Frankfurt	150
5	Berlin	520
6	Berlin	100
7	Nürnberg	50
8	Hamburg	100
9	Berlin	25
10	Hamburg	450
...

SELECT using SUM and GROUP BY

```
SELECT          City, SUM(Stock)
FROM            Products
GROUP BY       City
```

City	SUM(Stock)
Frankfurt	225
Berlin	657
Nürnberg	50
Hamburg	550
...	

DML: SQL Functions: AVG, SUM, MIN, MAX, COUNT

■ Further Aggregation Functions

- AVG(x) returns the average value of x
 - SUM(x) returns the sum of x
 - MIN(x) returns the minimum value of x
 - MAX(x) returns the maximum value of x
 - COUNT(x) returns the number of values for x
 - STDDEV(x) returns the standard deviation of x.
- x denotes an array of values (e.g. as the result of a SELECT query).

**INSERT INTO
VALUES**

**Product_Info
(2689875627,6,'1280X1024',55)**

Table “Product_Info”

<u>ID</u>	Article_No	Weight	Resolution	Power_Consumption
1	1297812542	4	1280X1024	26
2	2457897145	5	1280X1024	29
3	1297467815	4	1280X1024	27
4	2459871327	5.5	1280X1024	34
5	2789441512	8	1600X1280	53
6	2689875627	6	1280X1024	55
..				

Note: The “ID” column is a primary key and is automatically inserted with the new record.

INSERT INTO

Product_Info (Article_no, Weight,
Resolution, Power_consumption)
(2689875627,6,'1280X1024',55)

VALUES

Table “Product_Info”

<u>ID</u>	Article_no	Weight	Resolution	Power_consumption
1	1297812542	4	1280X1024	26
2	2457897145	5	1280X1024	29
3	1297467815	4	1280X1024	27
4	2459871327	5.5	1280X1024	34
5	2789441512	8	1600X1280	53
6	2689875627	6	1280X1024	55
..				

Note: The “ID” column is a primary key and is automatically inserted with the new record.


```

UPDATE      Product_Info
SET         Weight = 12
WHERE      Article_no = 2689875627
    
```

Table “Product_Info”

<u>ID</u>	Article_no	Weight	Resolution	Power_consumption
1	1297812542	4	1280X1024	26
2	2457897145	5	1280X1024	29
3	1297467815	4	1280X1024	27
4	2459871327	5.5	1280X1024	34
5	2789441512	8	1600X1280	53
6	2689875627	12	1280X1024	55
..				

```
UPDATE Product_Info
SET Weight = 12, Resolution = '1800X1400'
WHERE Article_no = 2689875627
```

Table “Product_Info”

<u>ID</u>	Article_no	Weight	Resolution	Power_consumption
1	1297812542	4	1280X1024	26
2	2457897145	5	1280X1024	29
3	1297467815	4	1280X1024	27
4	2459871327	5.5	1280X1024	34
5	2789441512	8	1600X1280	53
6	2689875627	12	1800X1400	55
..				

```
DELETE FROM      Product_Info
WHERE           Article_no = 2689875627
```

Table “Product_Info”

<u>ID</u>	Article_no	Weight	Resolution	Power_consumption
1	1297812542	4	1280X1024	26
2	2457897145	5	1280X1024	29
3	1297467815	4	1280X1024	27
4	2459871327	5.5	1280X1024	34
5	2789441512	8	1600X1280	53
..				

deleted:

6	2689875627	12	1280X1024	55
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- JOINS are used to create links between two or more tables.
- Tables are associated with each other by using unique keys.
- A primary key (or unique key) is a column containing a unique value for each row in a table.
- Some types of JOINS are:
 - **INNER JOIN**
 - **OUTER JOIN**
 - **LEFT JOIN**
 - **RIGHT JOIN**

Example Tables for JOIN and UNION

Table “Products”

<u>ID</u>	Product_name	Colour	Article_no	Sale_price	Purchase_price	Stock	Items_sold	City
1	Monitor 17“	white	1297812542	399.00	249.99	50	134	Frankfurt
2	Monitor 19“	black	2457897145	499.00	379.00	12	289	Berlin
3	Monitor 17“	black	1297467815	405.00	249.99	25	124	Frankfurt
4	Monitor 19“	white	2459871327	509.00	389.99	150	12	Frankfurt
5	Monitor 20“	black	2789441512	799.00	599.00	520	1052	Berlin
..								

Table “Product_Info”

<u>ID</u>	Article_no	Weight	Resolution	Power_consumption
1	1297812542	4	1280X1024	26
2	2457897145	5	1280X1024	29
3	2459871327	5.5	1280X1024	34
4	2789441512	8	1600X1280	53
..				

SELECT statement using INNER JOIN

SELECT
FROM

```
Products.Product_Name, Product_Info.Weight  
Products INNER JOIN Product_Info ON  
Products.Article_No = Product_Info.Article_No
```

Product_name	Weight
Monitor 17"	4
Monitor 19"	5
Monitor 19"	5.5
Monitor 20"	8

INNER JOIN combines selected columns of two or more tables by linking them together using a unique key from each table (here **Article_no**).

UNION combines the results from two SELECT statements

```
SELECT ID, Article_no FROM Products
UNION
SELECT ID, Article_no FROM Product_Info
```

<u>ID</u>	Article_no
1	1297812542
2	2457897145
3	1297467815
4	2459871327
5	2789441512

```
SELECT ID, Article_no FROM Products
UNION ALL
SELECT ID, Article_no FROM Product_Info
```

<u>ID</u>	Article_no
1	1297812542
2	2457897145
3	1297467815
4	2459871327
5	2789441512
1	1297812542
2	2457897145
3	2459871327
4	2789441512

- UNION** combines the results of two SQL SELECT queries to a single result set. For this, the same number of columns and compatible data types are required in each SELECT statement. Duplicate records are automatically removed unless **UNION ALL** is used.

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- “Stored procedure”
 - constitutes a logical unit of multiple SQL statements saved in a database,
 - allows more complex statements and offers several programming language aspects (e.g. use of variables).

```
CREATE PROCEDURE product_weight  
AS  
SELECT          Products.Product_name, Product_Info.Weight  
FROM           Products INNER JOIN Product_Info ON  
                Products.Article_no = Product_Info.Article_no
```

Product name	Weight
Monitor 17"	4
Monitor 19"	5
Monitor 19"	5.5
Monitor 20"	8

Stored Procedures using Variables

Table “Product_Info”

<u>ID</u>	Article_no	Weight	Resolution	Power_consumption
1	1297812542	4	1280X1024	26
2	2457897145	5	1280X1024	29
4	2459871327	5.5	1280X1024	34
5	2789441512	8	1600X1280	53
6	2689875627	6	1280X1024	55
..				

```
CREATE PROCEDURE  
add_product_info
```

```
@Article_no integer(10),  
@Weight decimal(2,1)  
@Resolution varchar(12),  
@Power_consumption integer(4)
```

```
AS
```

```
INSERT INTO Product_info (Article_no, Weight, Resolution,  
Power_consumption)  
VALUES (@Article_no, @Weight, @Resolution,  
@Power_consumption)
```

- Execution of Stored Procedures
 - The product_weight procedure does neither accept nor require any input parameters:

```
exec product_weight
```

- The add_detail procedure requires input parameters:
 - Variables are used to pass data to the procedure:

```
exec add_product_info 2689875627, 6, '1280X1024', 55
```

- A database *trigger* is a stored procedure which is **automatically executed** in case predefined events occur within in a database.
- Typical Trigger events are the insertion, update or deletion of data sets.

- Triggers can be used to:
 - enforce business rules (e.g. verify that every invoice has at least one item);
 - replicate data (e.g. create a history record for every data modification, which can be transferred to a data warehouse later);
 - enhance database performance (e.g. update account balance after every transaction for faster queries);
 - maintain the integrity of information in the database;
 - log data modifications (e.g. add time-stamp from server clock);
 - ...

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- Compatibility issues between different manufacturer implementations of the SQL standard



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- Created in 1998 as a school for web developers, offering free courses and exercises on web development.
- No download required, available under <https://www.w3schools.com/sql/>.
- Will be used in this course.

SQL Statement:

```
SELECT * FROM Customers;
```

Edit the SQL Statement, and click "Run SQL" to see the result.

Run SQL »

Result:

Number of Records: 91

CustomerID	CustomerName	ContactName	Address	City	PostalCode	Country
1	Alfreds Futterkiste	Maria Anders	Obere Str. 57	Berlin	12209	Germany
2	Ana Trujillo Emparedados y helados	Ana Trujillo	Avda. de la Constitución 2222	México D.F.	05021	Mexico
3	Antonio Moreno Taquería	Antonio Moreno	Mataderos 2312	México D.F.	05023	Mexico
4	Around the Horn	Thomas Hardy	120 Hanover Sq.	London	WA1 1DP	UK

Your Database:

Tablenames	Records
Customers	91
Categories	8
Employees	10
OrderDetails	518
Orders	196
Products	77
Shippers	3
Suppliers	29

- Alan Beaulieu (2009) Einführung in SQL, O'Reilly.

