DATA AND
ARTIFICIAL INTELLIGENCE

Performance Optimization and Best Practices in SQL

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Learning Objectives

By the end of this lesson, you will be able to:

- Implement an execution plan in SQL
- Compare VARCHAR, CHAR, and NVARCHAR
- List the index guidelines and analyze the creation of XML PATH and INDEX
- Outline queries with SQL indexes

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Execution Plan in SQL

Execution Plan in SQL

- Unlike other database solutions, MySQL does not generate byte-code to execute a query result. Instead, the query execution plan is used.
- The query execution plan is a list of instructions that the query execution must follow to produce the query result.
- It converts the source code (SQL query) into an executable program.

Execution Plan in SQL

Problem Scenario:

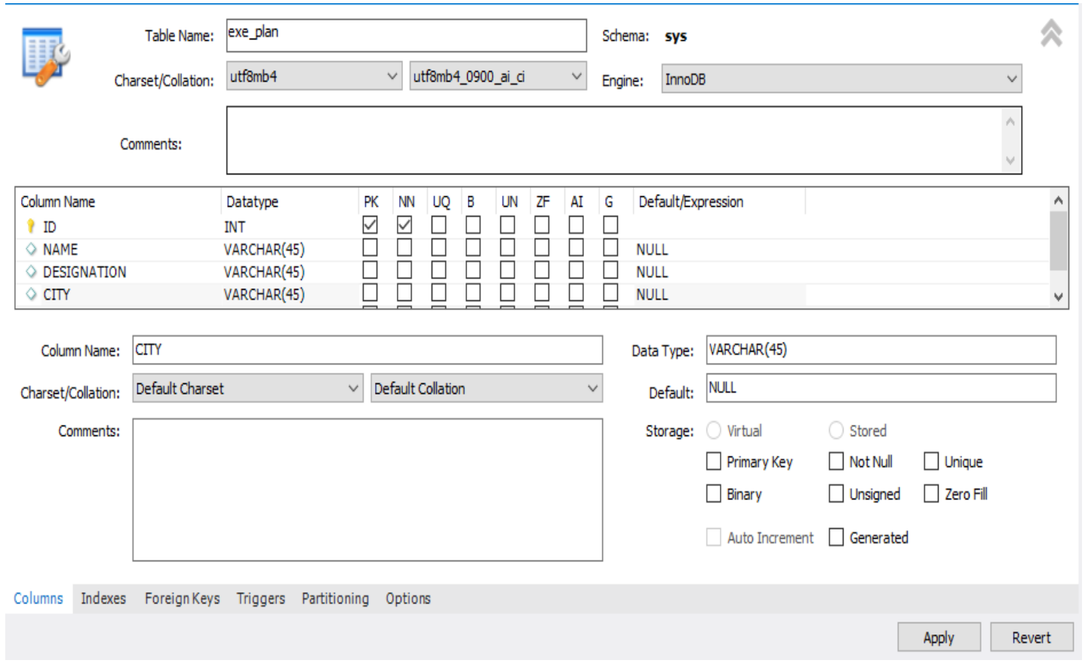
A data analyst of a company wants to check the execution plan for a query to view the performance and cost of the query.

Objective:

View the execution plan and create an index on the query to improve efficiency of the query.

Execution Plan in SQL

Create table Emp_info



QUERY

```
CREATE TABLE EXE_PLAN (
    ID int,
    NAME varchar(255),
    DESIGNATION varchar(255),
    CITY varchar(255),
);
```

Execution Plan in SQL

Insert data in a table

```
1 • INSERT INTO sys.exe_plan (ID,NAME,DESIGNATION,CITY) VALUES ('4', 'KARENE', 'SLD', 'Bangkok');
2 • select *from sys.exe_plan;
```

Result Grid | Filter Rows: | Edit: | Export/Import: | Wrap Cell Content:

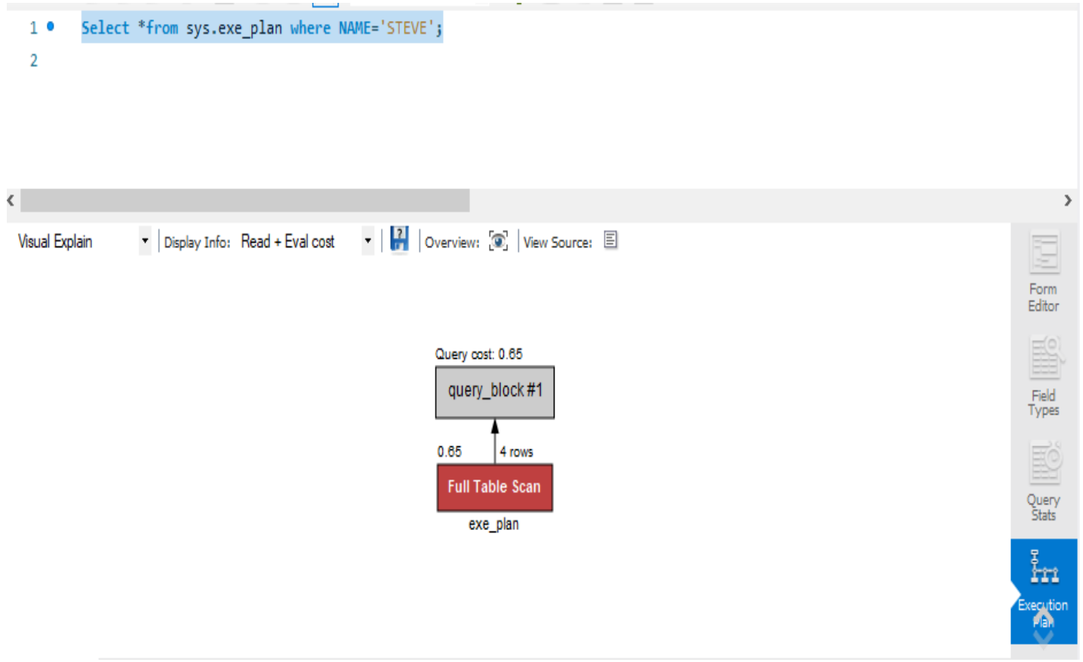
ID	NAME	DESIGNATION	CITY
1	ROY	SLD	Noida
2	KATRINA	LD	New York
3	STEVE	LD	Paris
4	KARENE	SLD	Bangkok
NULL	NULL	NULL	NULL

QUERY

INSERT INTO sys.exe_plan (ID,NAME,DESIGNATION,CITY)
VALUES (‘3', ‘STEVE', 'LD', ‘Paris');

Select *from sys.exe_plan;

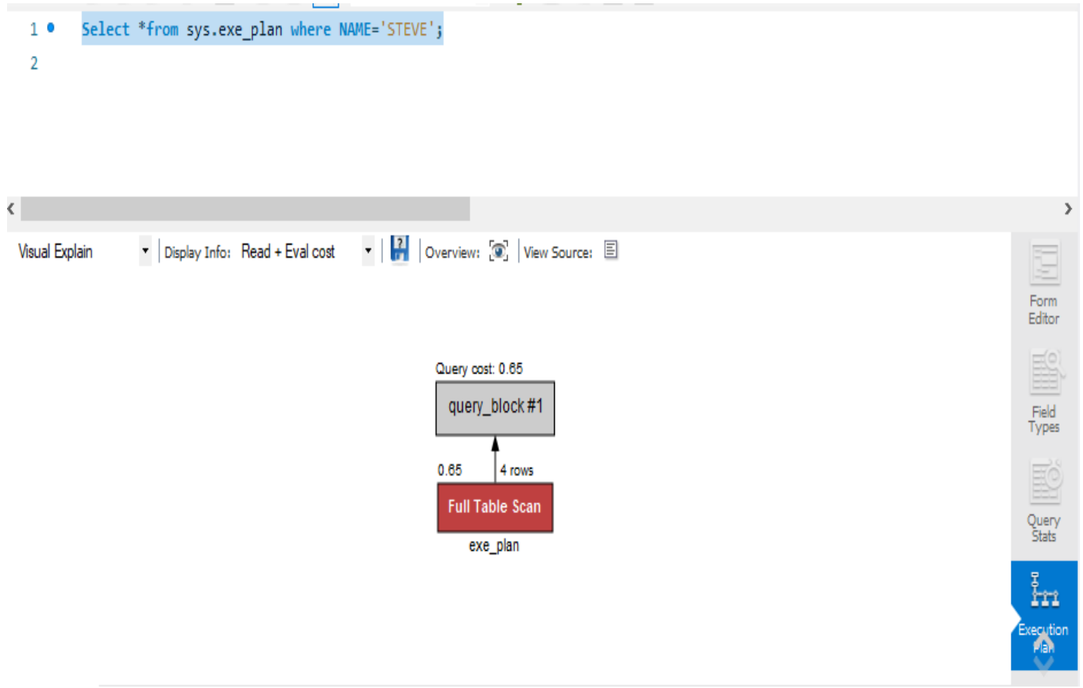
Execution Plan in SQL



QUERY

```
select *from sys.exe_plan where NAME='STEVE';
```

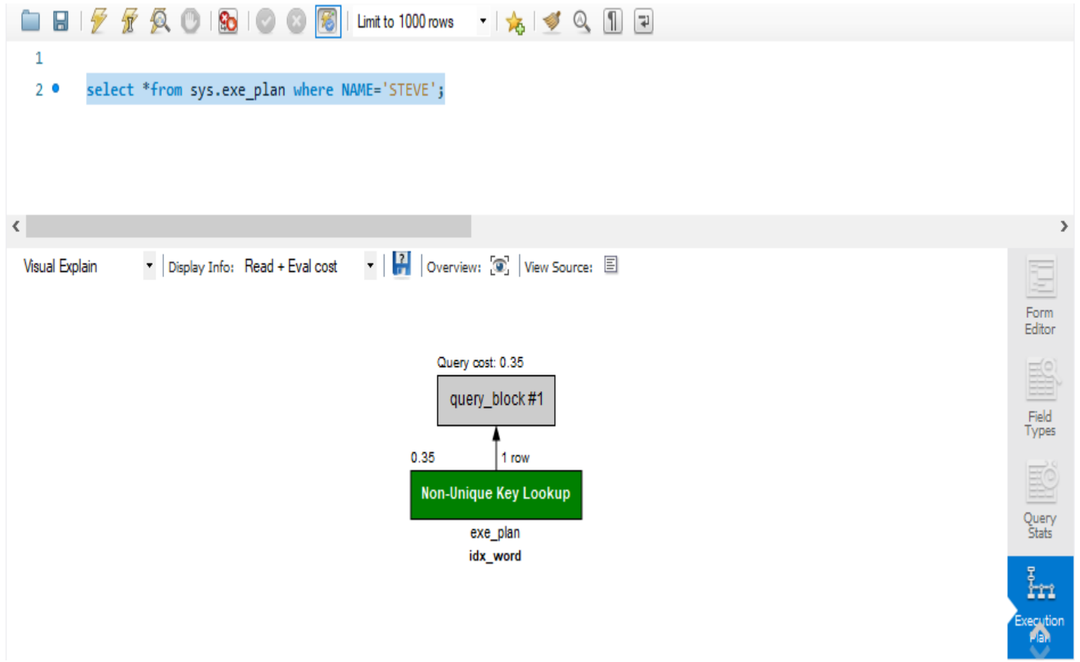
Execution Plan in SQL



- The image shows the execution plan, and the red box which is in the image is due to the Performance and high cost of the query.
- Query cost is a metric used in MySQL to determine how expensive a query is in terms of the overall cost of query execution.

Execution Plan in SQL

Creating an index to enhance the query performance



QUERY

```
create index idx_word on exe_plan(NAME);

select *from sys.exe_plan where NAME='STEVE';
```

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Difference Between CHAR, VARCHAR, and NVARCHAR

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Difference Between CHAR, VARCHAR, and NVARCHAR

CHAR	VARCHAR	NVARCHAR
It's a data type with a set length.	It's a data type with a changeable length.	It's a data type with a changeable length.
Non-Unicode characters are stored here.	Non-Unicode characters are stored here.	Unicode characters are stored here.
Each character is given one byte of space.	Each character takes one byte of memory.	Each character takes two bytes of memory.

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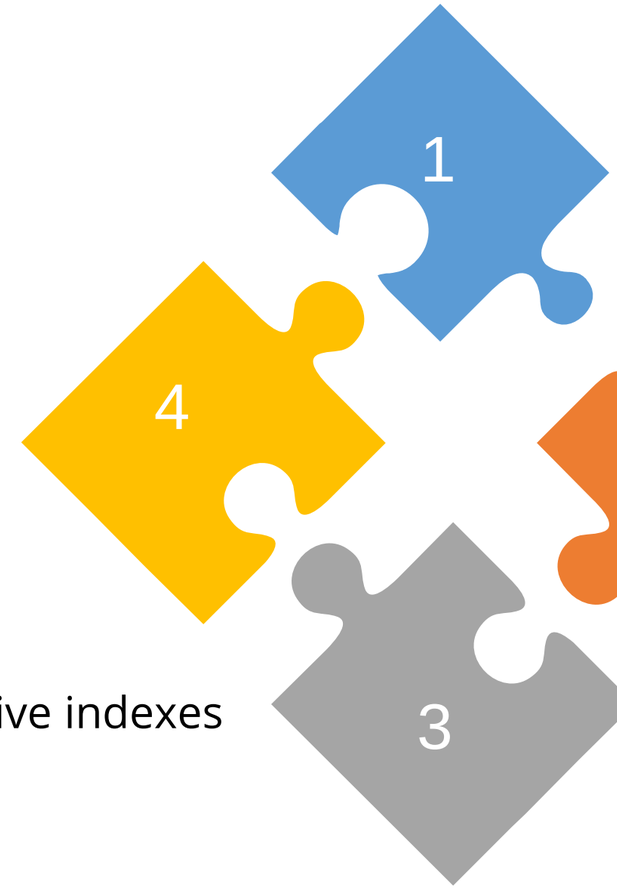
Index Guidelines

Index Guidelines

Choosing the right columns and types for an index is a crucial part of building a useful index.

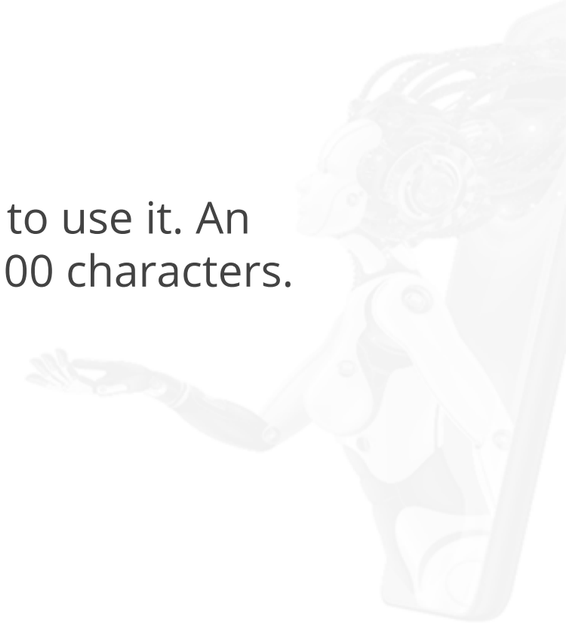


1. Keep index keys as short as possible
2. Keep separate index keys
3. Keep selective indexes
4. Keep indexes up-to-date

Index Guidelines

Keep index keys as short as possible

The larger an index key gets, the harder it is for a database to use it. An integer key is smaller than a character field that can carry 100 characters. Keep clustered indexes as short as possible.



Index Guidelines

Keep separate index keys

Indexes with a limited percentage of duplicated values are the most effective. With a decent index, the database will be able to ignore as many records as possible.

Index Guidelines

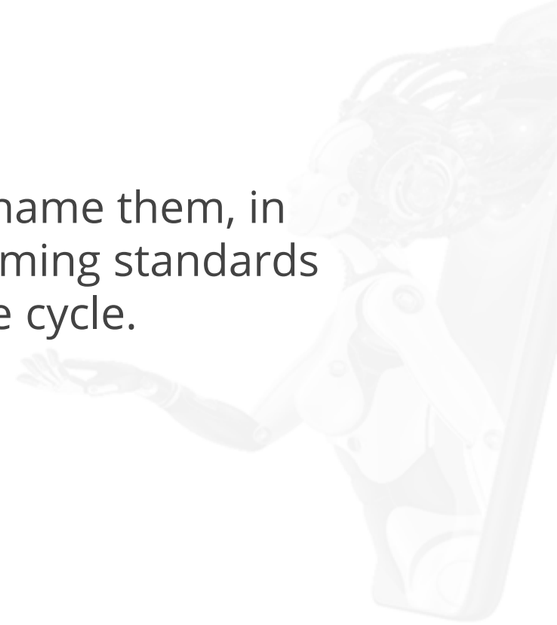
Keep selective indexes

A selective index has a lot of unique values. A unique index is the most selective of all the indexes, because there are no duplicate values.

Index Guidelines

Keeping indexes up-to-date

You will need to see existing indexes as well as delete or rename them, in addition to generating new ones. As the schema or even naming standards change, this is part of the database's continual maintenance cycle.



Creating a Clustered Index in SQL

Clustered Index in SQL

- A clustered index is an index that reorders the actual storage of entries in a table.
- Each table can only have one clustered index.

Clustered Index in SQL

Following are the essential characteristics of a clustered index:

It allows us to store both data and indexes at the same time.

It only has one manner of storing data, which is dependent on the key values.

It's an excellent choice for range or group queries that return min, max, or count values.

It always takes one or more columns to create an index.

Covering Queries With Indexes in SQL

A covered query is a query where all the columns in the query's result set are pulled from non-clustered indexes.

The careful placement of indexes transforms a query into a covered query.

Clustered Index in SQL

Problem Scenario:

A data analyst wants to sort a table in order, with the help of a clustered index. Create a primary key which acts as a clustered index in that table.

Objective:

Implement the clustered index to obtain the result.

Instructions:

Refer the emp_data table created before and perform the objectives.

Table Description

Field Name	Description
EMP_ID	Employee ID
FIRST_NAME	First name of the employee
LAST_NAME	Last name of the employee
GENDER	Gender of the employee (M/F)
ROLE	Designation of the employee (Junior, Senior, Lead, and Associate Data Scientist)
DEPT	Name of the department (Retail, Finance, Automotive, and Healthcare)

Table Description

Field Name	Description
EXP	Experience of the employee
COUNTRY	Country where the employee lives
CONTINENT	Continent based on the country
SALARY	Salary of the employee per month
EMP_RATING	Rating for the employee (1: Not Achieving Any Goals, 2: Below Expectations, 3: Meeting Expectations, 4: Excellent Performance, 5: Overachiever
MANAGER_ID	It is the employee ID for the manager

Clustered Index in SQL

In the query below, the PRIMARY KEY is a clustered index.

QUERY

```
CREATE TABLE
emp_data( `EMP_ID` Varchar NOT NULL,  `FIRST_NAME` varchar(45) DEFAULT NULL,  `LAST_NAME` var
char(3) DEFAULT NULL,  `GENDER` varchar(20) DEFAULT NULL,  `ROLE` varchar(25) DEFAULT NULL,  `D
EPT` varchar(25) DEFAULT NULL,  `EXP` varchar(25) DEFAULT NULL,  `COUNTRY` varchar(25) DEFAULT N
ULL,  `CONTINENT` varchar(25) DEFAULT NULL, `SALARY` INT  DEFAULT NULL,  `EMP_RATING` INT
DEFAULT NULL, `MANAGER_ID` varchar(25) DEFAULT NULL,     PRIMARY KEY (`EMP_ID`)//
clustered index  UNIQUE KEY `SALARY` (`SALARY`) ;
```

Clustered Index in SQL

Output

Result Grid | Filter Rows: | Export: | Wrap Cell Content:

EMP_ID	FIRST_NAME	LAST_NAME	GENDER	ROLE	DEPT	EXP	COUNTRY	CONTINENT	SALARY	EMP_RATIN
E260	Roy	Collins	M	SENIOR DATA SCIENTIST	RETAIL	7	INDIA	ASIA	7000	3
E245	Nian	Zhen	M	SENIOR DATA SCIENTIST	RETAIL	6	CHINA	ASIA	6500	2
E620	Katrina	Allen	F	JUNIOR DATA SCIENTIST	RETAIL	2	INDIA	ASIA	3000	1
E640	Jenifer	Jhones	F	JUNIOR DATA SCIENTIST	RETAIL	1	COLOMBIA	SOUTH AMERICA	2800	4
E403	Steve	Hoffman	M	ASSOCIATE DATA SCIENTIST	FINANCE	4	USA	NORTH AMERICA	5000	3
E204	Karene	Nowak	F	SENIOR DATA SCIENTIST	AUTOMOTIVE	8	GERMANY	EUROPE	7500	5
E204	Karene	Nowak	F	SENIOR DATA SCIENTIST	AUTOMOTIVE	8	GERMANY	EUROPE	7500	5
E010	William	Butler	M	LEAD DATA SCIENTIST	AUTOMOTIVE	12	FRANCE	EUROPE	9000	2
E478	David	Smith	M	ASSOCIATE DATA SCIENTIST	RETAIL	3	COLOMBIA	SOUTH AMERICA	4000	4
E005	Eric	Hoffman	M	LEAD DATA SCIENTIST	FINANCE	11	USA	NORTH AMERICA	8500	3
E532	Claire	Brennan	F	ASSOCIATE DATA SCIENTIST	AUTOMOTIVE	3	GERMANY	EUROPE	4300	1
E583	Janet	Hale	F	MANAGER	RETAIL	14	COLOMBIA	SOUTH AMERICA	10000	2
E103	Emily	Grove	F	MANAGER	FINANCE	14	CANADA	NORTH AMERICA	10500	4
E612	Tracy	Norris	F	MANAGER	RETAIL	13	INDIA	ASIA	8500	4
E428	Pete	Allen	M	MANAGER	AUTOMOTIVE	14	GERMANY	EUROPE	11000	4
E002	Cynthia	Brooks	F	PRESIDENT	ALL	17	CANADA	NORTH AMERICA	14500	5
E002	Cynthia	Brooks	F	PRESIDENT	ALL	17	CANADA	NORTH AMERICA	14500	5

Assisted Practice: Covering Query

Duration: 15 min

Problem Statement: You are required to create the temperature as unique, add new index columns, and view the index of the weather table for data integrity.

ASSISTED PRACTICE

Assisted Practice: Covering Query

Steps to be performed:

Step 1 : Creating the weather table and inserting values in it:

CREATE

```
CREATE TABLE weather (    temp INT NOT NULL,    windspeed
varchar(45) NOT NULL,    vapour varchar(45) NOT NULL,
climate varchar(45) NOT NULL  );
```

-

INSERT

```
INSERT INTO weather(temp,windspeed,vapour,climate) VALUES
('35','120km/hr','21','summer');
```

ASSISTED PRACTICE

Assisted Practice: Covering Query

Step 2 : Querying to create unique index:

QUERY

```
CREATE UNIQUE INDEX temp_index ON weather(temp);
```

Step 3 : Querying to add new index:

QUERY

```
ALTER TABLE weather ADD INDEX
index_co1_col2(windspeed,vapour,climate);
```

ASSISTED PRACTICE

Assisted Practice: Covering Query

Step 3 : Querying to show index:

QUERY

```
SHOW INDEX FROM weather;
```

Output :

Table	Non_unique	Key_name	Seq_in_index	Column_name	Collation	Cardinality	Sub_part	Packed	Null	Index_type	Comment	Index_comment	Visible	Expression
weather	0	temp_index	1	temp	A	0	NULL	NULL		BTREE			YES	NULL
weather	1	index_co1_col2	1	windspeed	A	6	NULL	NULL		BTREE			YES	NULL
weather	1	index_co1_col2	2	vapour	A	6	NULL	NULL		BTREE			YES	NULL
weather	1	index_co1_col2	3	dimate	A	6	NULL	NULL		BTREE			YES	NULL

ASSISTED PRACTICE

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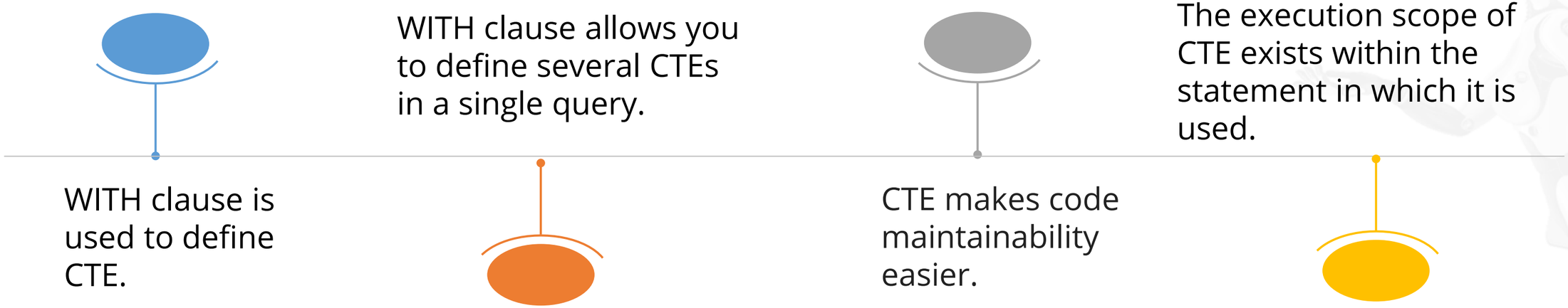
Common Table Expression

Common Table Expression

Each statement or query in MySQL generates a temporary result or relation. CREATE, INSERT, SELECT, UPDATE, DELETE, and other statements employ a common table expression (CTE) to name the temporary results sets that exist within the execution scope of that statement.

Common Table Expression

Following are some of the most important aspects of CTE:



Common Table Expression

The basic syntax of CTE in MySQL is as follows:

SYNTAX

```
WITH cte_name (column_names) AS (query)
SELECT * FROM cte_name;
```

Common Table Expression

Problem Scenario:

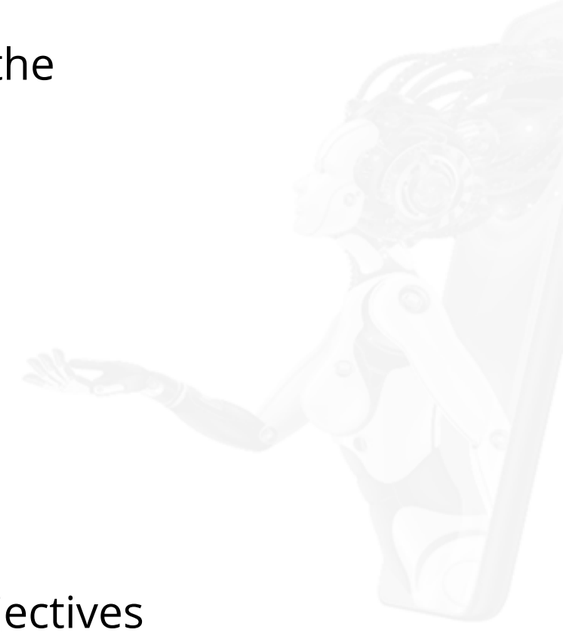
A data analyst wants to apply a CTE to the table with first name, last name, and the country of the person whose salary is greater than or equal to 4000.

Objective:

Implement the CTE to obtain the required result.

Instructions:

Refer the emp_data table which was created and shown before. Perform the objectives mentioned above.



Common Table Expression

Following **emp_data** table is used to show the CTE:

Result Grid | Filter Rows: | Export: | Wrap Cell Content:

EMP_ID	FIRST_NAME	LAST_NAME	GENDER	ROLE	DEPT	EXP	COUNTRY	CONTINENT	SALARY	EMP_RATING	MANAGER_ID
E204	Karene	Nowak	F	SENIOR DATA SCIENTIST	AUTOMOTIVE	8	GERMANY	EUROPE	7500	5	E428
E428	Pete	Allen	M	MANAGER	AUTOMOTIVE	14	GERMAN	GERMANY	11000	4	E002
E478	David	Smith	M	ASSOCIATE DATA SCIENTIST	RETAIL	3	COLOMBIA	SOUTH AMERICA	4000	4	E583
E532	Claire	Brennan	F	ASSOCIATE DATA SCIENTIST	AUTOMOTIVE	3	GERMANY	EUROPE	4300	1	E428
E583	Janet	Hale	F	MANAGER	RETAIL	14	COLOMBIA	SOUTH AMERICA	10000	2	E002
E612	Tracy	Norris	F	MANAGER	RETAIL	13	INDIA	ASIA	8500	4	E002
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E245	Nian	Zhen	M	SENIOR DATA SCIENTIST	RETAIL	6	CHINA	ASIA	6500	2	E583
E260	Roy	Collins	M	SENIOR DATA SCIENTIST	RETAIL	7	INDIA	ASIA	7000	3	E583
E403	Steve	Hoffman	M	ASSOCIATE DATA SCIENTIST	FINANCE	4	USA	NORTH AMERICA	5000	3	E103
E620	Katrina	Allen	F	JUNIOR DATA SCIENTIST	RETAIL	2	INDIA	ASIA	3000	1	E612
E640	Jenifer	Jhones	F	JUNIOR DATA SCIENTIST	RETAIL	1	COLOMBIA	SOUTH AMERICA	2800	4	E612

emp_data 3

Common Table Expression

CTE QUERY

```
WITH emp_in_Germany AS
(
 SELECT * FROM sys . emp_data WHERE COUNTRY = 'GERMANY'
 )

SELECT  FIRST_NAME , SALARY , COUNTRY from emp_in_Germany    WHERE SALARY >= '4000’ order by      FIRST_NAME;
```

Common Table Expression

Output:

Result Grid | Filter Rows: | Export: | Wrap Cell Content:

	FIRST_NAME	SALARY	COUNTRY
▶	Karene	7500	GERMANY
	Karene	7500	GERMANY
	Claire	4300	GERMANY

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SQL Best Practices

SQL Best Practices

Always check for NULLS in your data

Don’t use a query again if it does not serve its entire function

Always keep an eye on the execution plan and track of the time costs

Avoid sub queries, and do joins or write functions if required

SQL Best Practices

Use the right indexes for faster search results

Improve readability and maintainability, and ensure that the correct columns are retrieved

When your SQL statement has several sources, always utilize table aliases

In your INSERT statements, always use a column list

Key Takeaways

- Clustered index always uses one or more columns for creating an index.
- Choosing the right columns and types for an index is a crucial part of building a useful index.
- A covered query is a query where all the columns in the query's result set are pulled from non-clustered indexes.
- XML indexes can be constructed on XML data type columns. They boost query performance by indexing all tags, values, and routes across XML instances in the column.

Knowledge Check

Knowledge Check

1

Which of the following is one of the best practices in SQL?

A. Use the right indexes for slower search results

B. Make subqueries, and do not make joins or write functions

C. Always check for NULLS in your data

D. Use a query again if it does not serve its entire function

Knowledge Check

1

Which of the following is one of the best practices in SQL?

A. Use the right indexes for slower search results

B. Make subqueries, and do not make joins or write functions

C. Always check for NULLS in your data

D. Use a query again if it does not serve its entire function

The correct answer is: **C**

Always check for NULLS in your data. This is one of the main SQL practices.

Knowledge Check

2

Which of the following stores Unicode characters?

A. CHAR

B. VARCHAR

C. NVARCHAR

D. None of the above

Knowledge Check

2

Which of the following stores Unicode characters?

A. CHAR

B. VARCHAR

C. NVARCHAR

D. None of the above

The correct answer is: **C**

Unicode characters are stored in NVARCHAR.

Knowledge Check

3

Which of the following are index guidelines?

A. Keep index keys as short as possible

B. Keep separate index keys

C. Not keeping indexes up-to-date

D. Keeping a single key for indexes

Knowledge Check

3

Which of the following are index guidelines?

A. Keep index keys as short as possible

B. Keep separate index keys

C. Not keeping indexes up-to-date

D. Keeping a single key for indexes

The correct answers are: **A,B**

Index guidelines are keeping separate index keys and making them as short as possible.