Handling Missing Data in ETL

SECTION A – THEORETICAL QUESTIONS

QUESTION 1 What are the most common reasons for missing data in ETL pipelines?

ANSWER

1) Source system data gaps

Optional fields left blank by users

Data not captured due to application logic

Legacy systems with incomplete records

2) extraction failures

Partial job failures

Network or API timeouts

File corruption or missing files

3) Schema or structure changes

Columns renamed, removed, or added

Data type changes

4. Incorrect data mapping

Source column not mapped to target

Mapping logic errors

5. Filtering during transformatio

WHERE clauses removing records

Business rules excluding data

QUESTION 2	Why is blindly deleting rows with missing values considered a bad practice in ETL?
ANSWER	**1) Loss of valuable information**
	Missing values don’t always mean the entire record is useless.
	Example:
	A customer record missing phone number may still have valid name, email, and purchase data
	2) Data bias and wrong analytics
	Rows with missing values are often not random.
	3) Incorrect KPIs and reporting
	Dropping records reduces counts, totals, and averages.
	4) Breaks referential integrity
	Deleting rows can break relationships between tables.
	5) Hides upstream data issues
	Blind deletion masks problems in:
	Source systems
	ETL logic
	Data collection processes

QUESTION 3	Explain the difference between: Listwise deletion Column deletion
ANSWER	If a row has at least one missing value, the entire row is removed.
	Checks row by row
	One null (whole record deleted)
	If a column has many missing values, the entire column is removed.
	Evaluate missing % per column
	Drop columns exceeding threshold (e.g., 60%)
	Listwise deletion removes entire records when any value is missing, while column deletion removes entire attributes when a column contains excessive missing data. Both cause data loss and should be used only after business validation.

QUESTION 4	**Why is median imputation preferred over mean imputation for skewed data such as income?**
ANSWER	**1) Income data is highly skewed**
	Most people earn moderate incomes, while a few earn extremely high amounts
	2) Mean is sensitive to outliers
	A few very high incomes can dramatically increase the mean.
	3) Median represents the "typical" value
	The median reflects the middle of the distribution, not the extremes
	4) Prevents distortion of analysis & models
	Mean imputation:
	Inflates income values
	Skews KPIs like average salary
	Misleads ML models

QUESTION 5

What is forward fill and in what type of dataset is it most useful?

ANSWER

If a value is missing at time t, we copy the value from time t-1.

Date	Stock Price
Jan 1	100
Jan 2	NULL
Jan 3	NULL
Jan 4	105

AFTER

Date	Stock Price
Jan 1	100
Jan 2	100
Jan 3	100
Jan 4	105

Forward fill is best for time-series or sequential datasets where values change gradually and the previous value is still meaningful.

Data has a clear order (time, sequence)

Values change gradually

Missing values imply “no new value recorded”

QUESTION 6 Why should flagging missing values be done before imputation in an ETL workflow?

ANSWER

You don't lose information about "missingness"

Once you impute, you can no longer tell which values were originally missing.

Missingness itself can be meaningful

The fact that a value is missing can carry business or behavioral insight.

Better debugging and data audits

If reports look off later, flags help answer:

Which data was original?

Which data was imputed?

How much was imputed?

Protects downstream analytics & ML models

Imputed values look like real data.

Model bias checks

Sensitivity analysis

Feature engineering using missing indicators

Supports different business rules later

Different teams may want different treatments.

Improves trust and governance

Clear visibility into data modifications builds stakeholder confidence and meets governance requirements.

QUESTION 7

Consider a scenario where income is missing for many customers.
How can this missingness itself provide business insights?

ANSWER

1) Income missing may reflect customer behavior

High-income or privacy-conscious customers often choose not to disclose income.

2) Missingness can indicate trust or engagement levels

Customers who skip income fields may:

Not trust the platform yet

Be early-stage users

Have low engagement

3) Segment-specific patterns

Missing income might be concentrated in:

Certain age groups

Specific regions

Particular acquisition channels

4) Risk & eligibility signals

In lending or insurance:

Missing income can itself be a risk indicator

5) Strategic ETL takeaway

Instead of deleting or blindly imputing:

Add income_missing_flag = 1

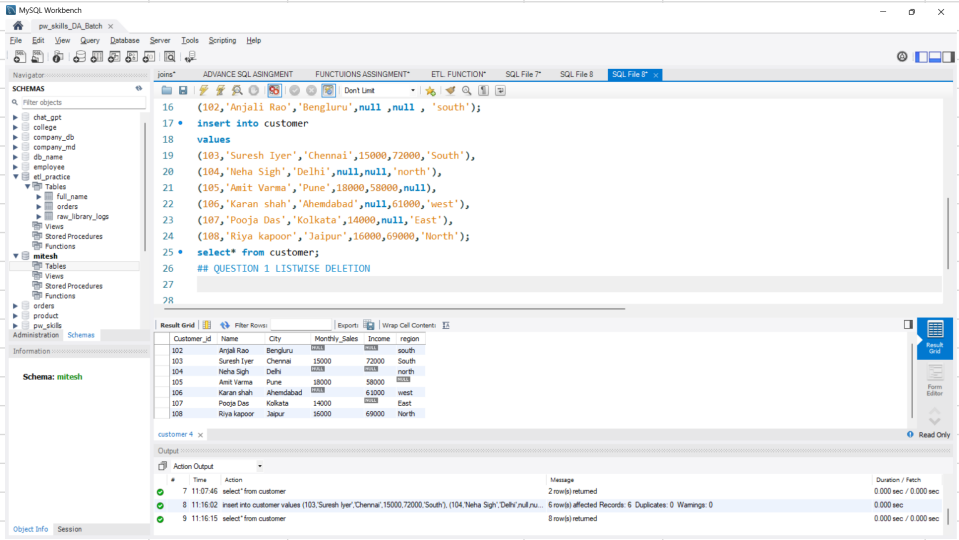
Analyze conversion, churn, or revenue by this flag

SECTION B – PRACTICAL QUESTIONS

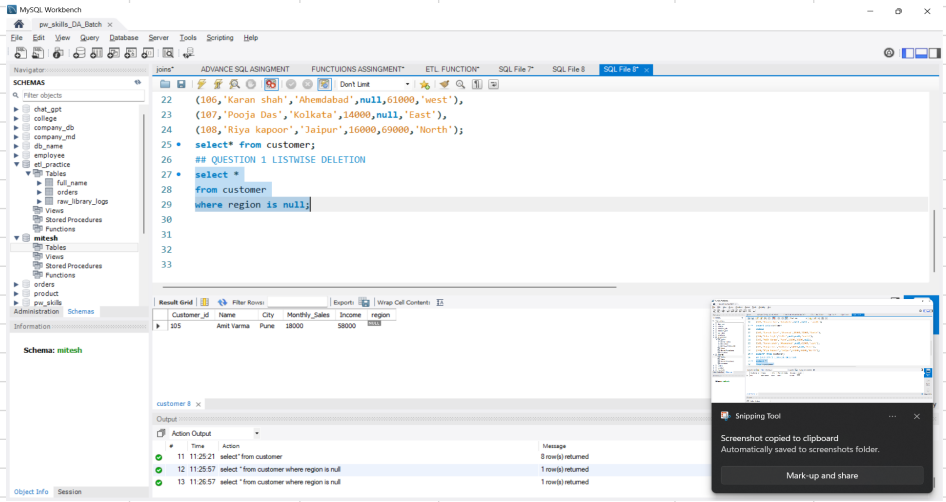
QUESTION 8

Listwise Deletion Remove all rows where Region is missing.
Identify affected rows
Show the dataset after deletion
Mention how many records were lost

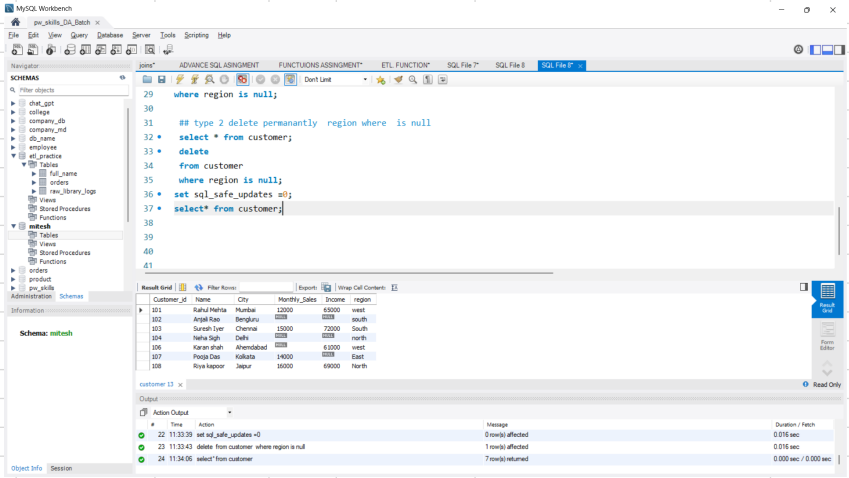
ANSWER



1)Identify affected rows



2) AFTER THE DELETION RESULT



QUESTION 9

Imputation

Handle missing values in Monthly_Sales using:

Forward Fill

Tasks:

- **Apply forward fill**
- **Show before vs after values**
- **Explain why forward fill is suitable here**

ANSWER

BEFORE

Customer_ID	Name	City	Monthly_Sales	Income	Region
1	Rahul Mehta	Mumbai	12000	65000	West
2	Neha Singh	Delhi	NaN	NaN	North
3	Anjali Rao	Bengaluru	NaN	NaN	South
4	Amit Verma	Pune	18000	58000	NaN
5	Pooja Das	Kolkata	14000	NaN	East
6	Suresh Iyer	Chennai	15000	72000	South
7	Karan Shah	Ahmedabad	NaN	61000	West
8	Riya Kapoor	Jaipur	16000	69000	North

TECHNIQUE 1	MEAN	15000

AFTER

Customer_ID	Name	City	Monthly_Sales	Income	Region
1	Rahul Mehta	Mumbai	12000	65000	West
2	Neha Singh	Delhi	12000	NaN	North
3	Anjali Rao	Bengaluru	12000	NaN	South
4	Amit Verma	Pune	18000	58000	NaN
5	Pooja Das	Kolkata	14000	NaN	East
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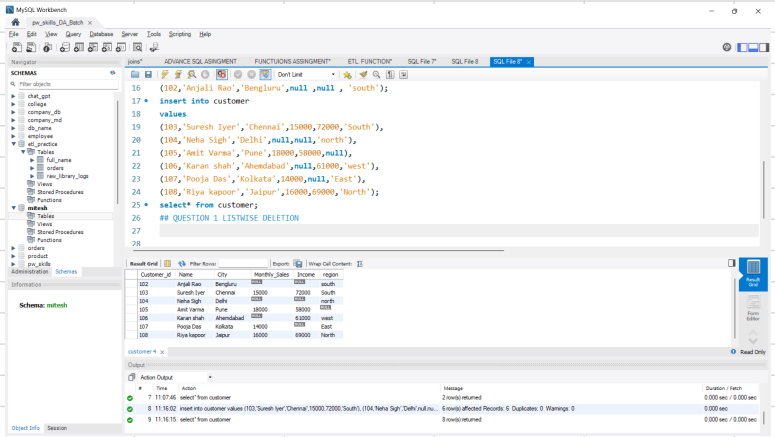

Explain why forward fill is suitable here

DATA IS A TIME SERIES

PREVIOUS VALUES IS LOGICALLY VALID FOR FORWORD FILL

SALES DATA CHANGE OVER THE TIME

QUESTION 10

Flagging Missing Data

Create a flag column for missing Income

Tasks:

Create Income_Missing_Flag (0 = present, 1 = missing)

Show updated dataset

Count how many customers have missing income

ANSWER

AFTER CHANGING THE MISSING INCOME
FLAGGING MISSING DATA

Customer_ID	Name	City	Monthly_Sales	Income	MISSING INCOME	Region
1	Rahul Mehta	Mumbai	12000	65000	0	West
2	Neha Singh	Delhi	NaN	NaN	1	North
3	Anjali Rao	Bengaluru	NaN	NaN	1	South
4	Amit Verma	Pune	18000	58000	0	NaN
5	Pooja Das	Kolkata	14000	NaN	1	East
6	Suresh Iyer	Chennai	15000	72000	0	South
7	Karan Shah	Ahmedabad	NaN	61000	0	West
8	Riya Kapoor	Jaipur	16000	69000	0	North

COUNT HOW MANY CUSTOMERS HAVE MISSING INCOME =3

TOTAL NUMBERS OF MISSING DATA = '3'