

Data Preprocessing Assignment:

```
[3]: import pandas as pd
df = pd.read_csv(r"D:\smartphones.csv")

# Display first few rows to preview the dataset
df.head()
```

```
[3]:
```

	model	price	rating	sim	processor	ram	battery	display	camera	card	os
0	OnePlus 11 5G	₹54,999	89.0	Dual Sim, 3G, 4G, 5G, VoLTE, Wi-Fi, NFC	Snapdragon 8 Gen2, Octa Core, 3.2 GHz Processor	12 GB RAM, 256 GB inbuilt	5000 mAh Battery with 100W Fast Charging	6.7 inches, 1440 x 3216 px, 120 Hz Display wit...	50 MP + 48 MP + 32 MP Triple Rear & 16 MP Fron...	Memory Card Not Supported	Android v13
1	OnePlus Nord CE 2 Lite 5G	₹19,989	81.0	Dual Sim, 3G, 4G, 5G, VoLTE, Wi-Fi	Snapdragon 695, Octa Core, 2.2 GHz Processor	6 GB RAM, 128 GB inbuilt	5000 mAh Battery with 33W Fast Charging	6.59 inches, 1080 x 2412 px, 120 Hz Display wi...	64 MP + 2 MP + 2 MP Triple Rear & 16 MP Front ...	Memory Card (Hybrid), upto 1 TB	Android v12
2	Samsung Galaxy A14 5G	₹16,499	75.0	Dual Sim, 3G, 4G, 5G, VoLTE, Wi-Fi	Exynos 1330, Octa Core, 2.4 GHz Processor	4 GB RAM, 64 GB inbuilt	5000 mAh Battery with 15W Fast Charging	6.6 inches, 1080 x 2408 px, 90 Hz Display with...	50 MP + 2 MP + 2 MP Triple Rear & 13 MP Front ...	Memory Card Supported, upto 1 TB	Android v13
3	Motorola Moto G62 5G	₹14,999	81.0	Dual Sim, 3G, 4G, 5G, VoLTE, Wi-Fi	Snapdragon 695, Octa Core, 2.2 GHz Processor	6 GB RAM, 128 GB inbuilt	5000 mAh Battery with Fast Charging	6.55 inches, 1080 x 2400 px, 120 Hz Display wi...	50 MP + 8 MP + 2 MP Triple Rear & 16 MP Front ...	Memory Card (Hybrid), upto 1 TB	Android v12
4	Realme 10 Pro Plus	₹24,999	82.0	Dual Sim, 3G, 4G, 5G, VoLTE, Wi-Fi	Dimensity 1080, Octa Core, 2.6 GHz Processor	6 GB RAM, 128 GB inbuilt	5000 mAh Battery with 67W Fast Charging	6.7 inches, 1080 x 2412 px, 120 Hz Display wit...	108 MP + 8 MP + 2 MP Triple Rear & 16 MP Front...	Memory Card Not Supported	Android v13

```
# Check dataset info
df.info()

# Basic statistics for numerical columns
df.describe()

# Shape of the dataset
df.shape
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1020 entries, 0 to 1019
Data columns (total 11 columns):
#   Column      Non-Null Count  Dtype
---  -
0   model       1020 non-null   object
1   price       1020 non-null   object
2   rating      879 non-null    float64
3   sim         1020 non-null   object
4   processor   1020 non-null   object
5   ram         1020 non-null   object
6   battery     1020 non-null   object
7   display     1020 non-null   object
8   camera      1019 non-null   object
9   card        1013 non-null   object
10  os          1003 non-null   object
dtypes: float64(1), object(10)
memory usage: 87.8+ KB
(1020, 11)
```

```
# Fill numeric missing values
for col in df.select_dtypes(include=['int64', 'float64']).columns:
    df[col] = pd.to_numeric(df[col], errors='coerce') # Ensure numeric
    df[col] = df[col].fillna(df[col].mean())          # Assignment instead of inplace

# Fill categorical missing values
for col in df.select_dtypes(include=['object']).columns:
    if not df[col].mode().empty:
        df[col] = df[col].fillna(df[col].mode()[0]) # Assignment instead of inplace
print(df)
```

	model	price	rating	sim	processor	ram	battery	display	camera	card	os
0	Oneplus 11 5G	54999	89.0	Dual Sim, 3G, 4G, 5G, Volte, Wi-Fi, Nfc	Snapdragon 8 Gen2, Octa Core, 3.2 Ghz Processor	12 Gb Ram, 256 Gb Inbuilt	5000 Mah Battery With 100W Fast Charging	6.7 Inches, 1440 X 3216 Px, 120 Hz Display Wit...	50 Mp + 48 Mp + 32 Mp Triple Rear & 16 Mp Fron...	Memory Card Not Supported	Android V13
1	Oneplus Nord Ce 2 Lite 5G	19989	81.0	Dual Sim, 3G, 4G, 5G, Volte, Wi-Fi	Snapdragon 695, Octa Core, 2.2 Ghz Processor	6 Gb Ram, 128 Gb Inbuilt	5000 Mah Battery With 33W Fast Charging	6.59 Inches, 1080 X 2412 Px, 120 Hz Display Wi...	64 Mp + 2 Mp + 2 Mp Triple Rear & 16 Mp Front ...	Memory Card (Hybrid), Upto 1 Tb	Android V12
2	Samsung Galaxy A14 5G	16499	75.0	Dual Sim, 3G, 4G, 5G, Volte, Wi-Fi	Exynos 1330, Octa Core, 2.4 Ghz Processor	4 Gb Ram, 64 Gb Inbuilt	5000 Mah Battery With 15W Fast Charging	6.6 Inches, 1080 X 2408 Px, 90 Hz Display With...	50 Mp + 2 Mp + 2 Mp Triple Rear & 13 Mp Front ...	Memory Card Supported, Upto 1 Tb	Android V13
3	Motorola Moto G62 5G	14999	81.0	Dual Sim, 3G, 4G, 5G, Volte, Wi-Fi	Snapdragon 695, Octa Core, 2.2 Ghz Processor	6 Gb Ram, 128 Gb Inbuilt	5000 Mah Battery With Fast Charging	6.55 Inches, 1080 X 2400 Px, 120 Hz Display Wi...	50 Mp + 8 Mp + 2 Mp Triple Rear & 16 Mp Front ...	Memory Card (Hybrid), Upto 1 Tb	Android V12
4	Realme 10 Pro Plus	24999	82.0	Dual Sim, 3G, 4G, 5G, Volte, Wi-Fi	Dimensity 1080, Octa Core, 2.6 Ghz Processor	6 Gb Ram, 128 Gb Inbuilt	5000 Mah Battery With 67W Fast Charging	6.7 Inches, 1080 X 2412 Px, 120 Hz Display Wit...	108 Mp + 8 Mp + 2 Mp Triple Rear & 16 Mp Front...	Memory Card Not Supported	Android V13

```
df.to_csv("smartphones_cleaned.csv", index=False)
print("✅ Cleaned dataset saved as smartphones_cleaned.csv")
```

✅ Cleaned dataset saved as smartphones_cleaned.csv

```
# Display first few cleaned records
df.head()
```

	ram	battery \
0	12 GB RAM, 256 GB inbuilt	5000 mAh Battery with 100W Fast Charging
1	6 GB RAM, 128 GB inbuilt	5000 mAh Battery with 33W Fast Charging
2	4 GB RAM, 64 GB inbuilt	5000 mAh Battery with 15W Fast Charging
3	6 GB RAM, 128 GB inbuilt	5000 mAh Battery with Fast Charging
4	6 GB RAM, 128 GB inbuilt	5000 mAh Battery with 67W Fast Charging
...
1015	8 GB RAM, 128 GB inbuilt	5000 mAh Battery with 68.2W Fast Charging
1016	6 GB RAM, 128 GB inbuilt	5000 mAh Battery with 22.5W Fast Charging
1017	8 GB RAM, 256 GB inbuilt	5080 mAh Battery with 67W Fast Charging
1018	6 GB RAM, 128 GB inbuilt	5000 mAh Battery with Fast Charging
1019	8 GB RAM, 128 GB inbuilt	5000 mAh Battery with Fast Charging

	display \
0	6.7 inches, 1440 x 3216 px, 120 Hz Display wit...
1	6.59 inches, 1080 x 2412 px, 120 Hz Display wi...
2	6.6 inches, 1080 x 2408 px, 90 Hz Display with...
3	6.55 inches, 1080 x 2400 px, 120 Hz Display wi...
4	6.7 inches, 1080 x 2412 px, 120 Hz Display wit...
...	...
1015	6.67 inches, 1080 x 2460 px, 120 Hz Display wi...
1016	6.5 inches, 720 x 1600 px Display with Water D...
1017	6.6 inches, 1080 x 2460 px, 144 Hz Display wit...
1018	6.8 inches, 1080 x 2400 px Display with Punch ...
1019	6.5 inches, 1080 x 2400 px Display with Water ...

	camera \
0	50 MP + 48 MP + 32 MP Triple Rear & 16 MP Fron...
1	64 MP + 2 MP + 2 MP Triple Rear & 16 MP Front ...
2	50 MP + 2 MP + 2 MP Triple Rear & 13 MP Front ...
3	50 MP + 8 MP + 2 MP Triple Rear & 16 MP Front ...
4	108 MP + 8 MP + 2 MP Triple Rear & 16 MP Front...
...	...
1015	64 MP + 8 MP + 2 MP Triple Rear & 16 MP Front ...
1016	48 MP + 2 MP + Depth Sensor Triple Rear & 8 MP...
1017	64 MP + 8 MP + 2 MP Triple Rear & 16 MP Front ...
1018	108 MP + 8 MP + 2 MP Triple Rear & 32 MP Front...
1019	64 MP + 8 MP + 5 MP Triple Rear & 32 MP Front ...

	card	os
0	Memory Card Not Supported	Android v13
1	Memory Card (Hybrid), upto 1 TB	Android v12
2	Memory Card Supported, upto 1 TB	Android v13
3	Memory Card (Hybrid), upto 1 TB	Android v12
4	Memory Card Not Supported	Android v13
...
1015		Android v12 No FM Radio
1016	Memory Card Supported, upto 1 TB	Android v11
1017	Memory Card Not Supported	Android v12
1018	Memory Card Supported, upto 1 TB	Android v12
1019	Memory Card Supported, upto 1 TB	Android v12

[1020 rows x 11 columns]

```
# Count duplicates
print("Duplicates before removing:", df.duplicated().sum())

# Remove duplicate rows
df.drop_duplicates(inplace=True)

print("Duplicates after removing:", df.duplicated().sum())
```

Duplicates before removing: 0
 Duplicates after removing: 0

```
# Clean ₹, commas, Rs and convert price column to numeric
df['price'] = df['price'].astype(str).str.replace('₹', '', regex=False)
df['price'] = df['price'].str.replace(',', '', regex=False)
df['price'] = df['price'].str.replace('Rs', '', case=False, regex=False)
df['price'] = pd.to_numeric(df['price'], errors='coerce')

# Convert any date column to datetime (if present)
for col in df.columns:
    if 'date' in col.lower():
        df[col] = pd.to_datetime(df[col], errors='coerce')

# Check updated data types
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1020 entries, 0 to 1019
Data columns (total 11 columns):
#   Column      Non-Null Count  Dtype
---  -
0   model       1020 non-null  object
1   price       1020 non-null  int64
2   rating      1020 non-null  float64
3   sim         1020 non-null  object
4   processor   1020 non-null  object
5   ram         1020 non-null  object
6   battery     1020 non-null  object
7   display     1020 non-null  object
8   camera      1020 non-null  object
9   card        1020 non-null  object
10  os          1020 non-null  object
dtypes: float64(1), int64(1), object(9)
memory usage: 87.8+ KB
```

1016	Snapdragon 480+, Octa Core, 2.2 Ghz Processor
1017	Dimensity 8100, Octa Core, 2.85 Ghz Processor
1018	Snapdragon 695, Octa Core, 2.2 Ghz Processor
1019	Octa Core Processor

	ram	battery \
0	12 Gb Ram, 256 Gb Inbuilt	5000 Mah Battery With 100W Fast Charging
1	6 Gb Ram, 128 Gb Inbuilt	5000 Mah Battery With 33W Fast Charging
2	4 Gb Ram, 64 Gb Inbuilt	5000 Mah Battery With 15W Fast Charging
3	6 Gb Ram, 128 Gb Inbuilt	5000 Mah Battery With Fast Charging
4	6 Gb Ram, 128 Gb Inbuilt	5000 Mah Battery With 67W Fast Charging
...
1015	8 Gb Ram, 128 Gb Inbuilt	5000 Mah Battery With 68.2W Fast Charging
1016	6 Gb Ram, 128 Gb Inbuilt	5000 Mah Battery With 22.5W Fast Charging
1017	8 Gb Ram, 256 Gb Inbuilt	5080 Mah Battery With 67W Fast Charging
1018	6 Gb Ram, 128 Gb Inbuilt	5000 Mah Battery With Fast Charging
1019	8 Gb Ram, 128 Gb Inbuilt	5000 Mah Battery With Fast Charging

	display \
0	6.7 Inches, 1440 X 3216 Px, 120 Hz Display Wit...
1	6.59 Inches, 1080 X 2412 Px, 120 Hz Display Wi...
2	6.6 Inches, 1080 X 2408 Px, 90 Hz Display With...
3	6.55 Inches, 1080 X 2400 Px, 120 Hz Display Wi...
4	6.7 Inches, 1080 X 2412 Px, 120 Hz Display Wit...
...	...
1015	6.67 Inches, 1080 X 2460 Px, 120 Hz Display Wi...
1016	6.5 Inches, 720 X 1600 Px Display With Water D...
1017	6.6 Inches, 1080 X 2460 Px, 144 Hz Display Wit...
1018	6.8 Inches, 1080 X 2400 Px Display With Punch ...
1019	6.5 Inches, 1080 X 2400 Px Display With Water ...

	camera \
0	50 Mp + 48 Mp + 32 Mp Triple Rear & 16 Mp Fron...
1	64 Mp + 2 Mp + 2 Mp Triple Rear & 16 Mp Front ...
2	50 Mp + 2 Mp + 2 Mp Triple Rear & 13 Mp Front ...
3	50 Mp + 8 Mp + 2 Mp Triple Rear & 16 Mp Front ...
4	108 Mp + 8 Mp + 2 Mp Triple Rear & 16 Mp Front...
...	...
1015	64 Mp + 8 Mp + 2 Mp Triple Rear & 16 Mp Front ...
1016	48 Mp + 2 Mp + Depth Sensor Triple Rear & 8 Mp...
1017	64 Mp + 8 Mp + 2 Mp Triple Rear & 16 Mp Front ...
1018	108 Mp + 8 Mp + 2 Mp Triple Rear & 32 Mp Front...
1019	64 Mp + 8 Mp + 5 Mp Triple Rear & 32 Mp Front ...

	card	os
0	Memory Card Not Supported	Android V13
1	Memory Card (Hybrid), Upto 1 Tb	Android V12
2	Memory Card Supported, Upto 1 Tb	Android V13
3	Memory Card (Hybrid), Upto 1 Tb	Android V12
4	Memory Card Not Supported	Android V13
...
1015	Android V12	No Fm Radio
1016	Memory Card Supported, Upto 1 Tb	Android V11
1017	Memory Card Not Supported	Android V12
1018	Memory Card Supported, Upto 1 Tb	Android V12
1019	Memory Card Supported, Upto 1 Tb	Android V12

```
# Strip spaces and standardize text formatting
for col in df.select_dtypes('object').columns:
    df[col] = df[col].astype(str).str.strip()
    df[col] = df[col].str.replace(r'\s+', ' ', regex=True)
    df[col] = df[col].str.title()
print(df)
```

	model	price	rating	\
0	Oneplus 11 5G	54999	89.0	
1	Oneplus Nord Ce 2 Lite 5G	19989	81.0	
2	Samsung Galaxy A14 5G	16499	75.0	
3	Motorola Moto G62 5G	14999	81.0	
4	Realme 10 Pro Plus	24999	82.0	
...	
1015	Motorola Moto Edge S30 Pro	34990	83.0	
1016	Honor X8 5G	14990	75.0	
1017	Poco X4 Gt 5G (8Gb Ram + 256Gb)	28990	85.0	
1018	Motorola Moto G91 5G	19990	80.0	
1019	Samsung Galaxy M52S 5G	24990	74.0	

	sim	\
0	Dual Sim, 3G, 4G, 5G, Volte, Wi-Fi, Nfc	
1	Dual Sim, 3G, 4G, 5G, Volte, Wi-Fi	
2	Dual Sim, 3G, 4G, 5G, Volte, Wi-Fi	
3	Dual Sim, 3G, 4G, 5G, Volte, Wi-Fi	
4	Dual Sim, 3G, 4G, 5G, Volte, Wi-Fi	
...	...	
1015	Dual Sim, 3G, 4G, 5G, Volte, Wi-Fi	
1016	Dual Sim, 3G, 4G, 5G, Volte, Wi-Fi	
1017	Dual Sim, 3G, 4G, 5G, Volte, Wi-Fi, Nfc, Ir Bl...	
1018	Dual Sim, 3G, 4G, 5G, Volte, Wi-Fi, Nfc	
1019	Dual Sim, 3G, 4G, 5G, Volte, Wi-Fi	

	processor	\
0	Snapdragon 8 Gen2, Octa Core, 3.2 Ghz Processor	
1	Snapdragon 695, Octa Core, 2.2 Ghz Processor	
2	Exynos 1330, Octa Core, 2.4 Ghz Processor	
3	Snapdragon 695, Octa Core, 2.2 Ghz Processor	
4	Dimensity 1080, Octa Core, 2.6 Ghz Processor	
...	...	
1015	Snapdragon 8 Gen1, Octa Core, 3 Ghz Processor	

	ram	battery \
0	12 GB RAM, 256 GB inbuilt	5000 mAh Battery with 100W Fast Charging
1	6 GB RAM, 128 GB inbuilt	5000 mAh Battery with 33W Fast Charging
2	4 GB RAM, 64 GB inbuilt	5000 mAh Battery with 15W Fast Charging
3	6 GB RAM, 128 GB inbuilt	5000 mAh Battery with Fast Charging
4	6 GB RAM, 128 GB inbuilt	5000 mAh Battery with 67W Fast Charging
...
1015	8 GB RAM, 128 GB inbuilt	5000 mAh Battery with 68.2W Fast Charging
1016	6 GB RAM, 128 GB inbuilt	5000 mAh Battery with 22.5W Fast Charging
1017	8 GB RAM, 256 GB inbuilt	5080 mAh Battery with 67W Fast Charging
1018	6 GB RAM, 128 GB inbuilt	5000 mAh Battery with Fast Charging
1019	8 GB RAM, 128 GB inbuilt	5000 mAh Battery with Fast Charging

	display \
0	6.7 inches, 1440 x 3216 px, 120 Hz Display wit...
1	6.59 inches, 1080 x 2412 px, 120 Hz Display wi...
2	6.6 inches, 1080 x 2408 px, 90 Hz Display with...
3	6.55 inches, 1080 x 2400 px, 120 Hz Display wi...
4	6.7 inches, 1080 x 2412 px, 120 Hz Display wit...
...	...
1015	6.67 inches, 1080 x 2460 px, 120 Hz Display wi...
1016	6.5 inches, 720 x 1600 px Display with Water D...
1017	6.6 inches, 1080 x 2460 px, 144 Hz Display wit...
1018	6.8 inches, 1080 x 2400 px Display with Punch ...
1019	6.5 inches, 1080 x 2400 px Display with Water ...

	camera \
0	50 MP + 48 MP + 32 MP Triple Rear & 16 MP Fron...
1	64 MP + 2 MP + 2 MP Triple Rear & 16 MP Front ...
2	50 MP + 2 MP + 2 MP Triple Rear & 13 MP Front ...
3	50 MP + 8 MP + 2 MP Triple Rear & 16 MP Front ...
4	108 MP + 8 MP + 2 MP Triple Rear & 16 MP Front...
...	...
1015	64 MP + 8 MP + 2 MP Triple Rear & 16 MP Front ...
1016	48 MP + 2 MP + Depth Sensor Triple Rear & 8 MP...
1017	64 MP + 8 MP + 2 MP Triple Rear & 16 MP Front ...
1018	108 MP + 8 MP + 2 MP Triple Rear & 32 MP Front...
1019	64 MP + 8 MP + 5 MP Triple Rear & 32 MP Front ...