```python
# ===============================
# Data Science Mini Project
# Advanced Explorations Using Python
# ===============================

# 1. Import Libraries & Set Options
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns

# Set pandas display options
pd.set_option("display.max_columns", None)
pd.set_option("display.max_rows", 50)
sns.set_style("whitegrid")

# 2. Read Data
df = pd.read_csv("insurance.csv")
print("Dataset Loaded Successfully!")
print("Shape of data:", df.shape)
```

```
Dataset Loaded Successfully!
Shape of data: (1338, 7)
```

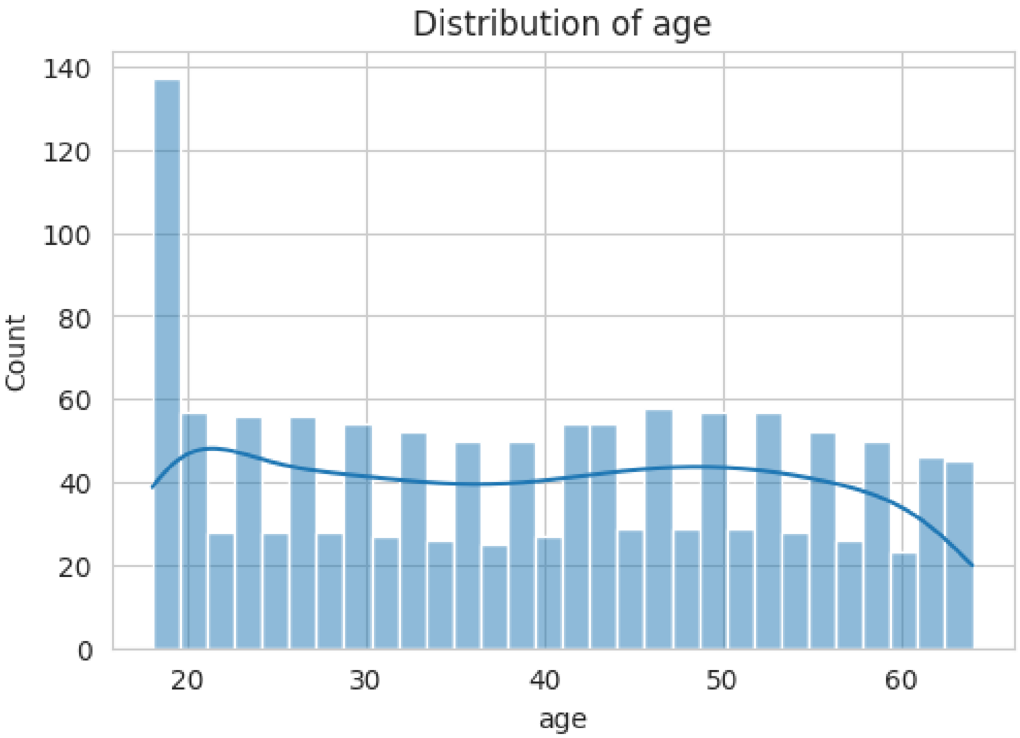
```python
# 3. Understand & Prepare Data
print("\n--- First 5 Rows ---")
print(df.head())
print("\n--- Data Info ---")
print(df.info())
print("\n--- Summary Statistics ---")
print(df.describe(include="all"))
```

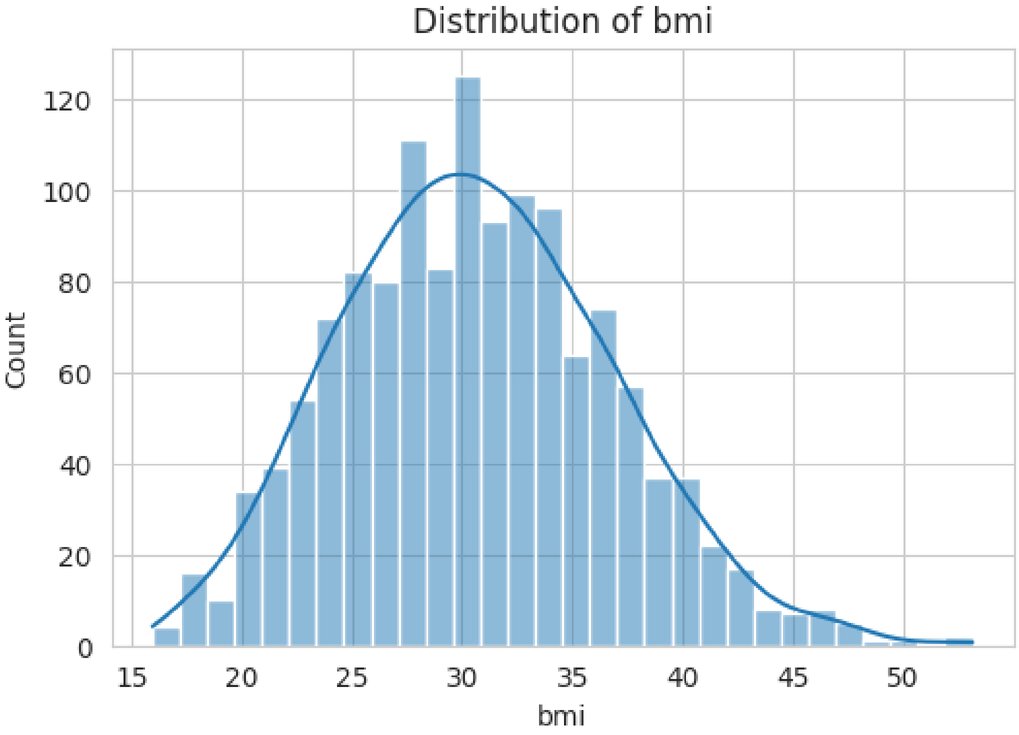
```
--- First 5 Rows ---
   age     sex     bmi  children smoker     region      charges
0   19  female  27.900         0    yes  southwest  16884.92400
1   18    male  33.770         1     no  southeast   1725.55230
2   28    male  33.000         3     no  southeast   4449.46200
3   33    male  22.705         0     no  northwest  21984.47061
4   32    male  28.880         0     no  northwest   3866.85520

--- Data Info ---
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1338 entries, 0 to 1337
Data columns (total 7 columns):
 #   Column    Non-Null Count  Dtype
---  ------    --------------  -----
 0   age       1338 non-null   int64
 1   sex       1338 non-null   object
 2   bmi       1338 non-null   float64
 3   children  1338 non-null   int64
 4   smoker    1338 non-null   object
 5   region    1338 non-null   object
 6   charges   1338 non-null   float64
dtypes: float64(2), int64(2), object(3)
memory usage: 73.3+ KB
None

--- Summary Statistics ---
                age   sex          bmi     children smoker     region
\
count   1338.000000  1338  1338.000000  1338.000000   1338       1338

unique          NaN     2          NaN          NaN      2          4

top             NaN  male          NaN          NaN     no  southeast

freq            NaN   676          NaN          NaN   1064        364

mean      39.207025   NaN    30.663397     1.094918    NaN        NaN

std       14.049960   NaN     6.098187     1.205493    NaN        NaN

min       18.000000   NaN    15.960000     0.000000    NaN        NaN

25%       27.000000   NaN    26.296250     0.000000    NaN        NaN

50%       39.000000   NaN    30.400000     1.000000    NaN        NaN

75%       51.000000   NaN    34.693750     2.000000    NaN        NaN

max       64.000000   NaN    53.130000     5.000000    NaN        NaN


             charges
count    1338.000000
unique           NaN
top              NaN
freq             NaN
mean    13270.422265
std     12110.011237
min      1121.873900
25%      4740.287150
50%      9382.033000
75%     16639.912515
max     63770.428010
```

```
#4.()) Understand the Variables (EDA Basics)
print("\n--- Unique values per column ---")
for col in df.columns:
    print(col, ":", df[col].nunique())
```

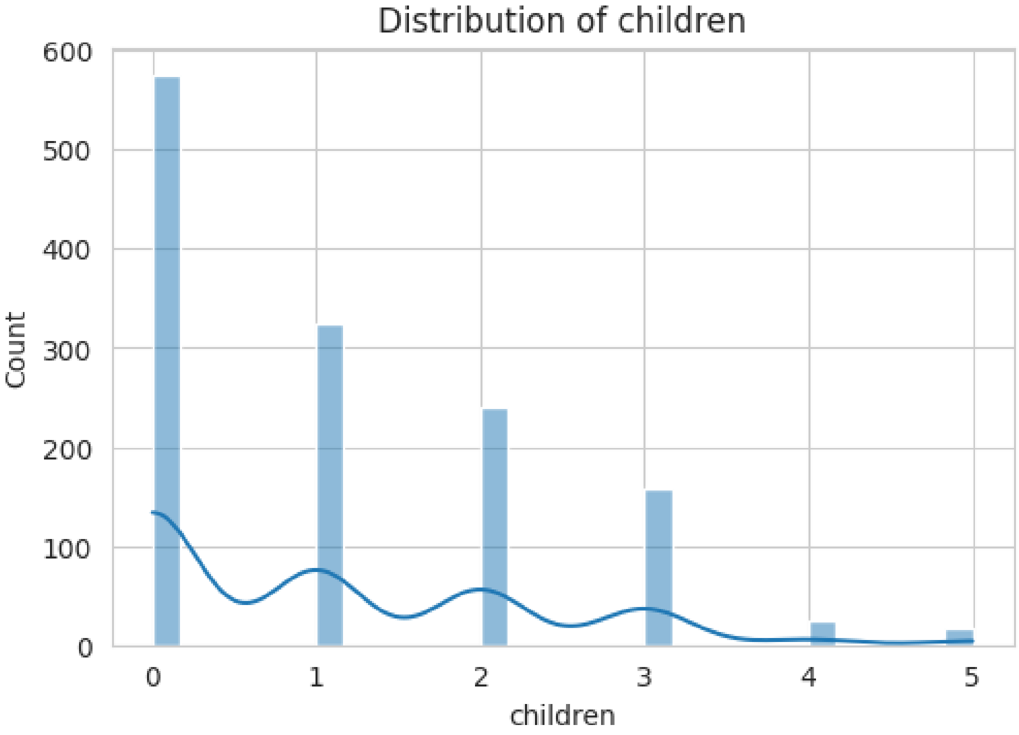
```
--- Unique values per column ---
age : 47
sex : 2
bmi : 548
children : 6
smoker : 2
region : 4
charges : 1337
```

```python
# Distribution plots for numerical features
num_cols = df.select_dtypes(include=np.number).columns
for col in num_cols:
    plt.figure(figsize=(6,4))
    sns.histplot(df[col], kde=True, bins=30)
    plt.title(f"Distribution of {col}")
    plt.show()
```

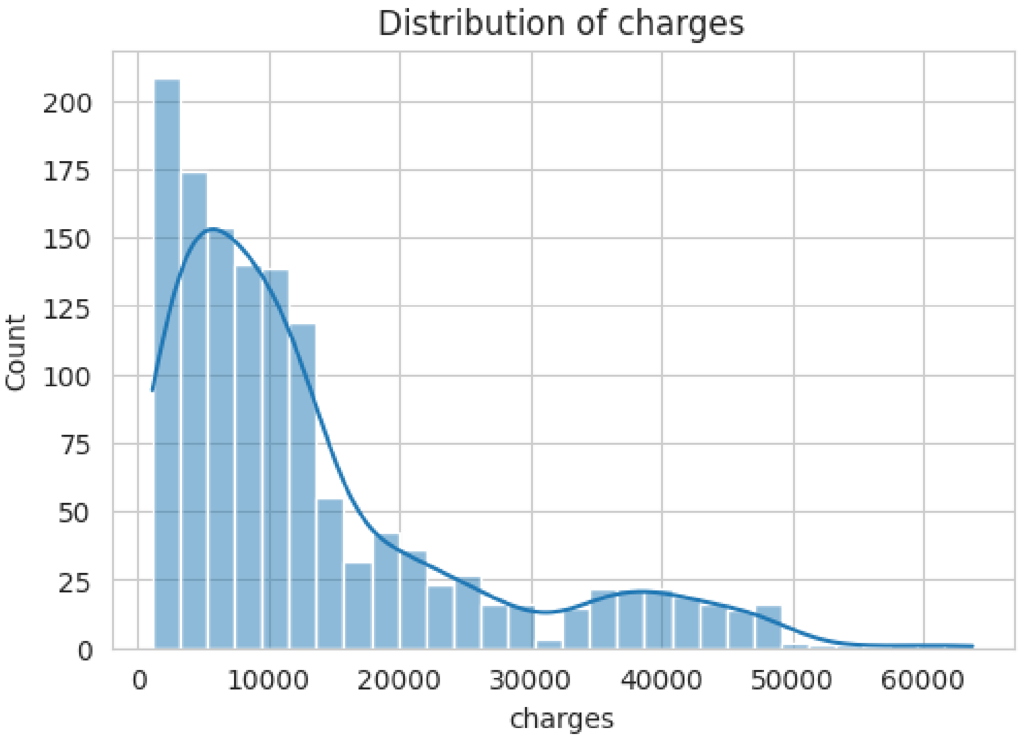




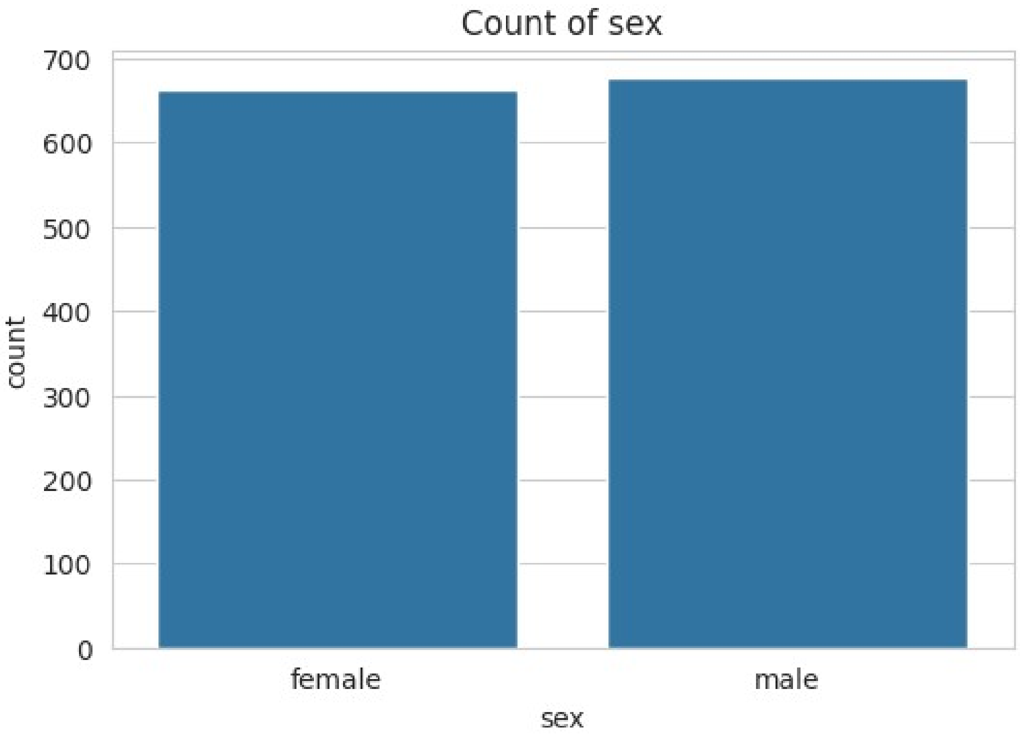
Distribution of bmi

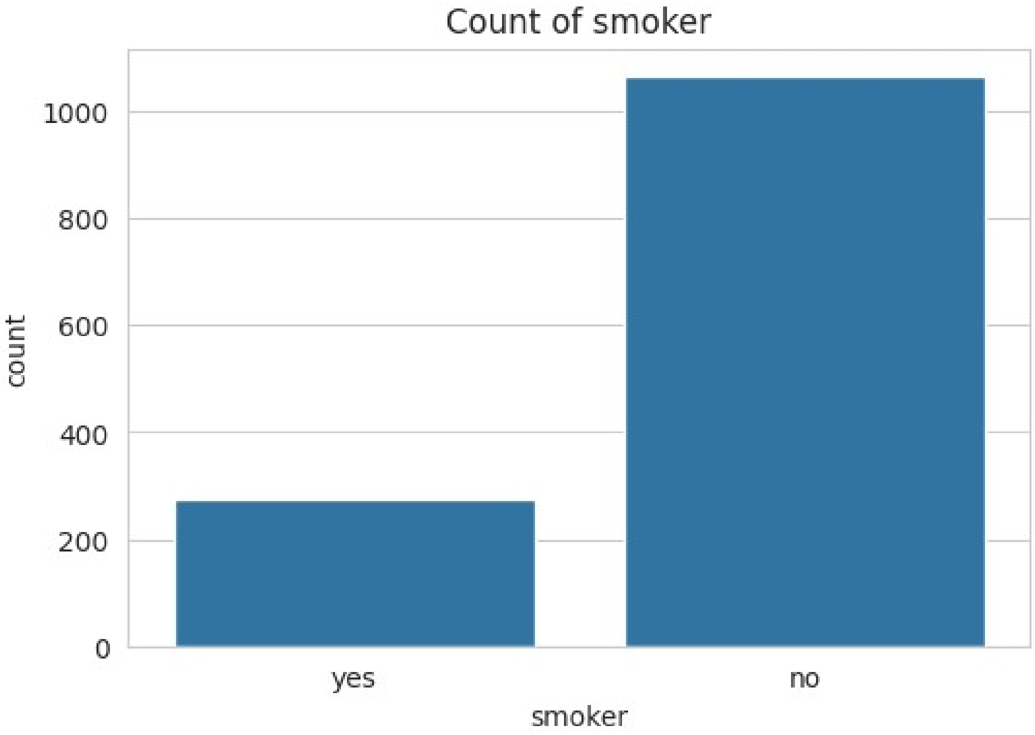


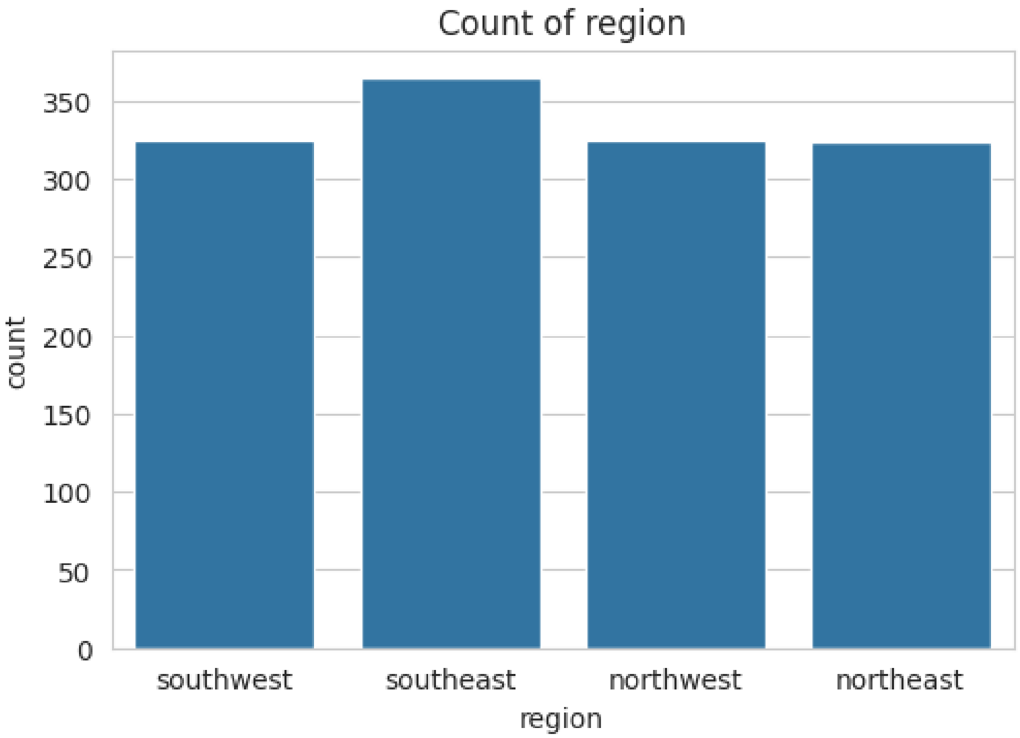
Distribution of children



```python
# Count plots for categorical features
cat_cols = df.select_dtypes(include="object").columns
for col in cat_cols:
    plt.figure(figsize=(6,4))
    sns.countplot(x=df[col])
    plt.title(f"Count of {col}")
    plt.show()
```


Count of sex
700
600
500
400
300
200
100
0
count
female
male
sex

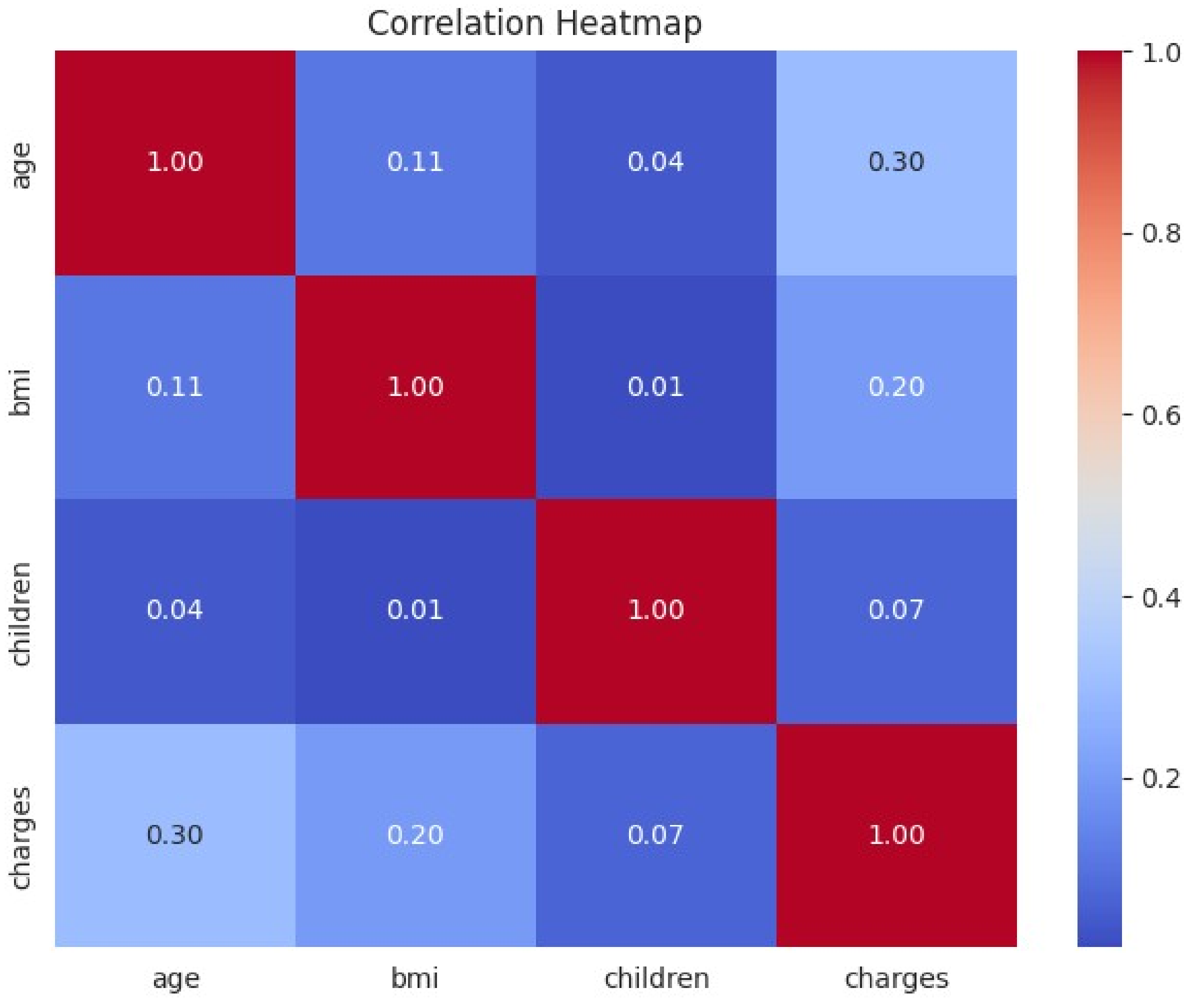

Count of smoker
1000
800
600
400
200
0
count
yes
no
smoker



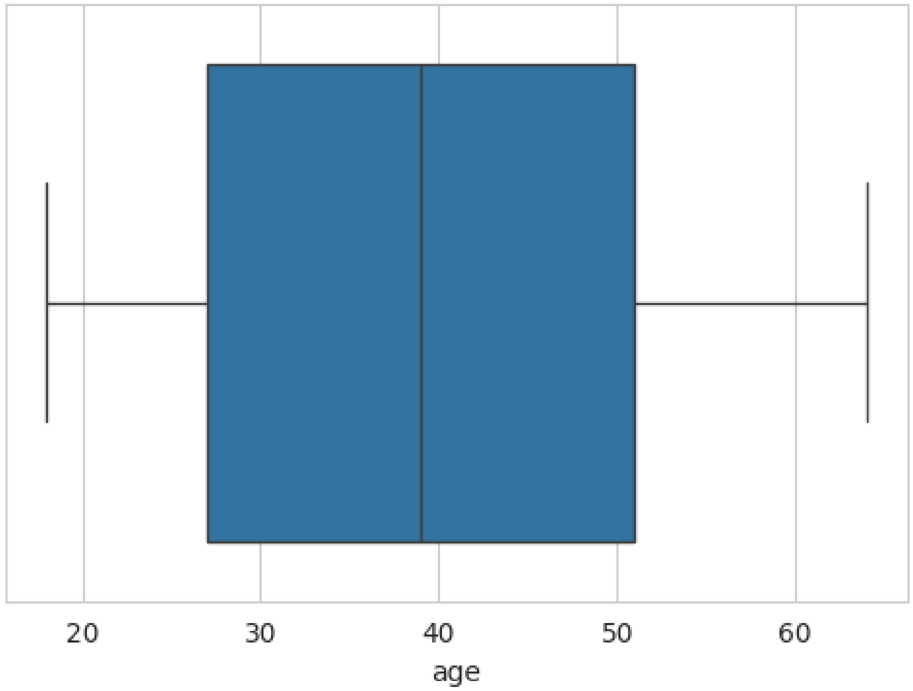
```python
# 5. Check for Missing Values
print("\n--- Missing Values ---")
print(df.isnull().sum())
```

```
--- Missing Values ---
age         0
sex         0
bmi         0
children    0
smoker      0
region      0
charges     0
dtype: int64
```

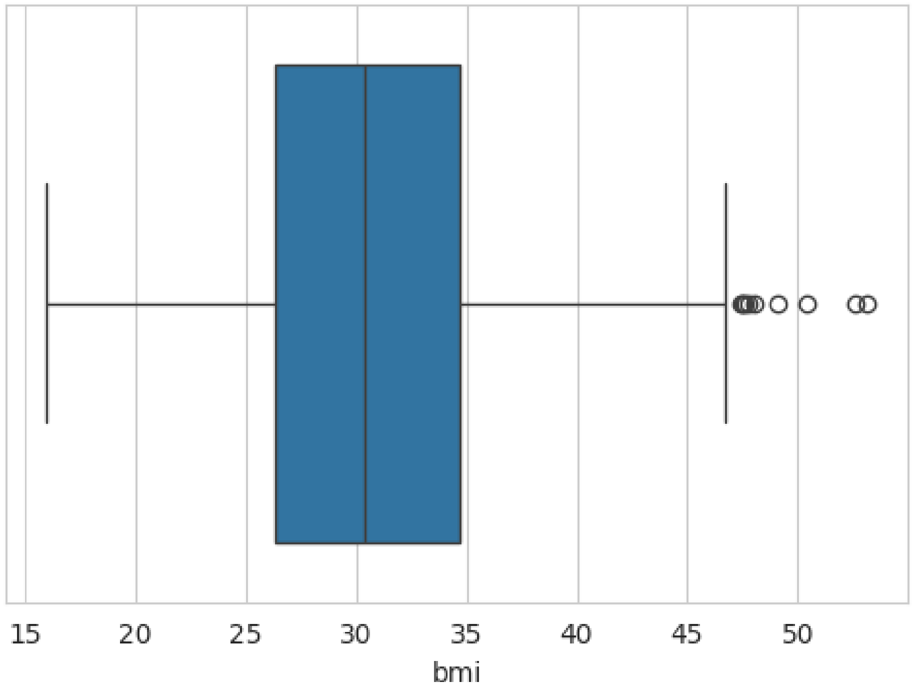
```python
# 6. Study Correlation (numeric only)
plt.figure(figsize=(8,6))
numeric_df = df.select_dtypes(include=[np.number])  # keep only numeric columns
sns.heatmap(numeric_df.corr(), annot=True, cmap="coolwarm", fmt=".2f")
plt.title("Correlation Heatmap")
plt.show()
```



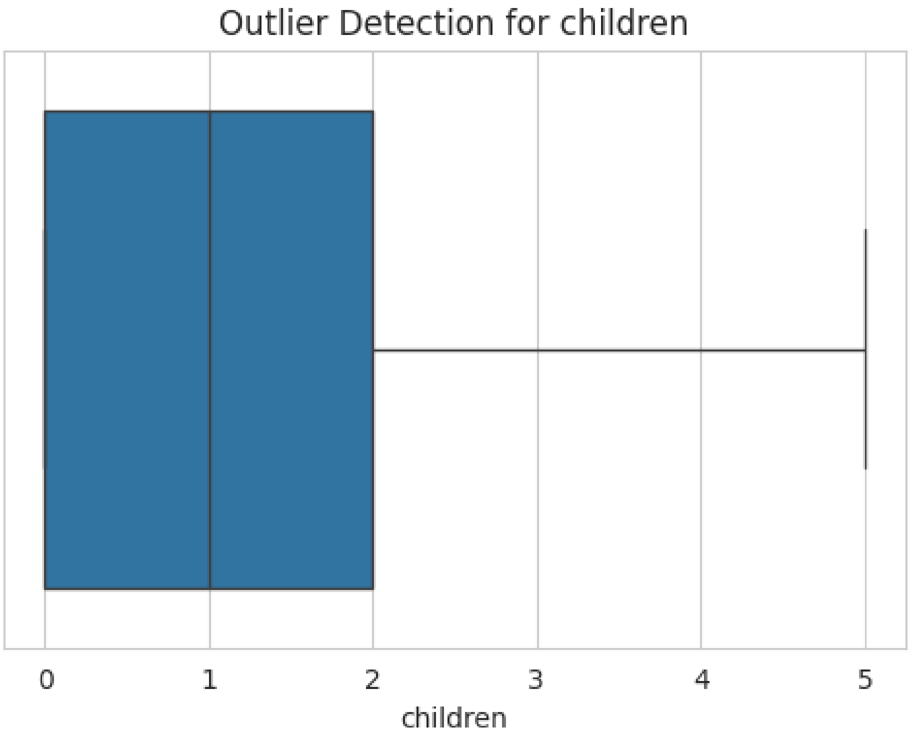
```
# 7. Detect Outliers
# Using Boxplots
for col in num_cols:
    plt.figure(figsize=(6,4))
    sns.boxplot(x=df[col])
    plt.title(f"Outlier Detection for {col}")
    plt.show()
```

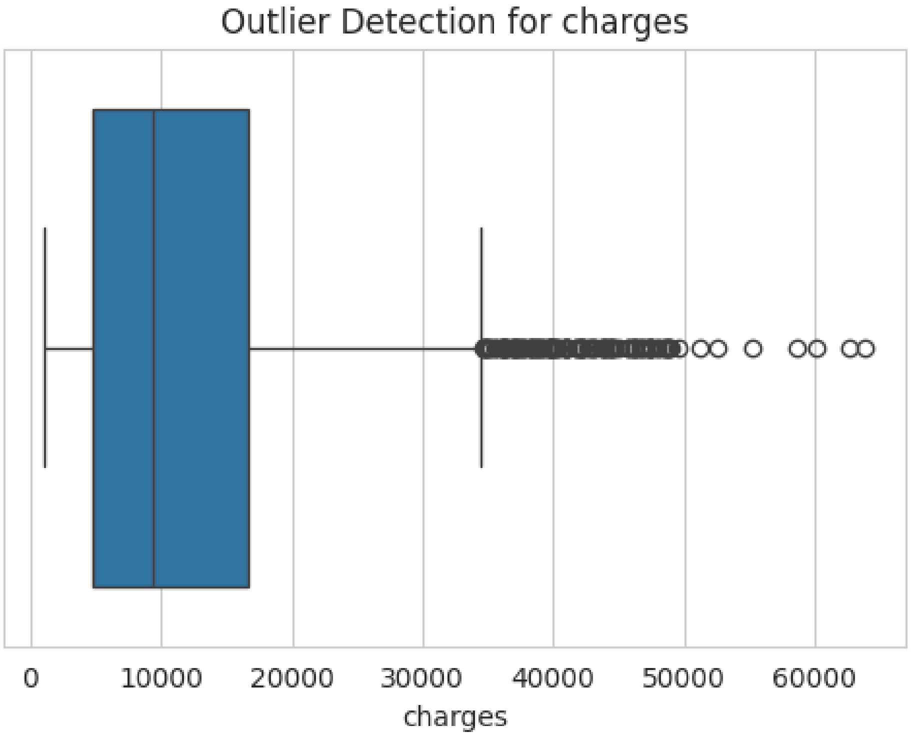


Outlier Detection for age



Outlier Detection for bmi





```
# Outlier detection using IQR
def detect_outliers_iqr(data, col):
    Q1 = data[col].quantile(0.25)
    Q3 = data[col].quantile(0.75)
    IQR = Q3 - Q1
    lower = Q1 - 1.5 * IQR
    upper = Q3 + 1.5 * IQR
    outliers = data[(data[col] < lower) | (data[col] > upper)]
    return outliers

for col in num_cols:
    outliers = detect_outliers_iqr(df, col)
    print(f"{col}: {len(outliers)} outliers")
```

```
age: 0 outliers
bmi: 9 outliers
children: 0 outliers
charges: 139 outliers
```

```
# 8. Feature Engineering – 'region' Variable
print("\n--- Feature Engineering on 'region' ---")
print(df['region'].value_counts())
```

```

--- Feature Engineering on 'region' ---
region
southeast    364
southwest    325
northwest    325
northeast    324
Name: count, dtype: int64
```

```
# Convert region into dummy variables
df_encoded = pd.get_dummies(df, columns=['region'], drop_first=True)
print("After Encoding, new columns:", df_encoded.columns)
```

```
After Encoding, new columns: Index(['age', 'sex', 'bmi', 'children',
'smoker', 'charges',
       'region_northwest', 'region_southeast', 'region_southwest'],
      dtype='object')
```

```
# Example: Create a new feature "is_southeast"
df["is_southeast"] = np.where(df["region"] == "southeast", 1, 0)
print(df[["region", "is_southeast"]].head())

print("\nFinal Dataset Shape:", df.shape)
```

```
      region  is_southeast
0  southwest             0
1  southeast             1
2  southeast             1
3  northwest             0
4  northwest             0
```

```
Final Dataset Shape: (1338, 8)
```