Obesity_risk_analysis

October 26, 2025

1 Obesity Risk Analisys and Prediction

[1]:
```
import numpy as np
import pandas as pd
from xgboost import XGBClassifier
from sklearn.preprocessing import LabelEncoder, StandardScaler, OneHotEncoder,␣
↪OrdinalEncoder
from sklearn.compose import ColumnTransformer
from sklearn.model_selection import train_test_split, GridSearchCV
from sklearn.metrics import accuracy_score, confusion_matrix
import matplotlib.pyplot as plt
import seaborn as sns
```

1.1 Data Loading

[2]:
```
train_df = pd.read_csv('train.csv')
test_df = pd.read_csv('test.csv')

print(train_df.head())
print(train_df.columns)
```

```
   id  Gender        Age    Height      Weight family_history_with_overweight  \
0   0    Male  24.443011  1.699998   81.669950                             yes
1   1  Female  18.000000  1.560000   57.000000                             yes
2   2  Female  18.000000  1.711460   50.165754                             yes
3   3  Female  20.952737  1.710730  131.274851                             yes
4   4    Male  31.641081  1.914186   93.798055                             yes

  FAVC      FCVC       NCP        CAEC SMOKE      CH2O SCC       FAF  \
0  yes  2.000000  2.983297   Sometimes    no  2.763573  no  0.000000
1  yes  2.000000  3.000000  Frequently    no  2.000000  no  1.000000
2  yes  1.880534  1.411685   Sometimes    no  1.910378  no  0.866045
3  yes  3.000000  3.000000   Sometimes    no  1.674061  no  1.467863
4  yes  2.679664  1.971472   Sometimes    no  1.979848  no  1.967973

        TUE       CALC                 MTRANS       WeightCategory
0  0.976473  Sometimes  Public_Transportation  Overweight_Level_II
1  1.000000         no             Automobile        Normal_Weight
```

```
2  1.673584         no  Public_Transportation  Insufficient_Weight
3  0.780199  Sometimes  Public_Transportation     Obesity_Type_III
4  0.931721  Sometimes  Public_Transportation  Overweight_Level_II
Index(['id', 'Gender', 'Age', 'Height', 'Weight',
       'family_history_with_overweight', 'FAVC', 'FCVC', 'NCP', 'CAEC',
       'SMOKE', 'CH2O', 'SCC', 'FAF', 'TUE', 'CALC', 'MTRANS',
       'WeightCategory'],
      dtype='object')
```

[3]:
```
print(train_df.info())
print(train_df.describe())
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 15533 entries, 0 to 15532
Data columns (total 18 columns):
 #   Column                          Non-Null Count  Dtype
---  ------                          --------------  -----
 0   id                              15533 non-null  int64
 1   Gender                          15533 non-null  object
 2   Age                             15533 non-null  float64
 3   Height                          15533 non-null  float64
 4   Weight                          15533 non-null  float64
 5   family_history_with_overweight  15533 non-null  object
 6   FAVC                            15533 non-null  object
 7   FCVC                            15533 non-null  float64
 8   NCP                             15533 non-null  float64
 9   CAEC                            15533 non-null  object
 10  SMOKE                           15533 non-null  object
 11  CH2O                            15533 non-null  float64
 12  SCC                             15533 non-null  object
 13  FAF                             15533 non-null  float64
 14  TUE                             15533 non-null  float64
 15  CALC                            15533 non-null  object
 16  MTRANS                          15533 non-null  object
 17  WeightCategory                  15533 non-null  object
dtypes: float64(8), int64(1), object(9)
memory usage: 2.1+ MB
None
                 id           Age        Height        Weight          FCVC  \
count  15533.000000  15533.000000  15533.000000  15533.000000  15533.000000
mean    7766.000000     23.816308      1.699918     87.785225      2.442917
std     4484.135201      5.663167      0.087670     26.369144      0.530895
min        0.000000     14.000000      1.450000     39.000000      1.000000
25%     3883.000000     20.000000      1.630927     66.000000      2.000000
50%     7766.000000     22.771612      1.700000     84.000000      2.342220
75%    11649.000000     26.000000      1.762921    111.600553      3.000000
max    15532.000000     61.000000      1.975663    165.057269      3.000000
```

	NCP	CH2O	FAF	TUE
count	15533.000000	15533.000000	15533.000000	15533.000000
mean	2.760425	2.027626	0.976968	0.613813
std	0.706463	0.607733	0.836841	0.602223
min	1.000000	1.000000	0.000000	0.000000
25%	3.000000	1.796257	0.007050	0.000000
50%	3.000000	2.000000	1.000000	0.566353
75%	3.000000	2.531456	1.582675	1.000000
max	4.000000	3.000000	3.000000	2.000000

1.2 Feature Engineering

[4]:
```
# ----------------------------------------------------------------
# STEP 1: Feature Engineering (Do this first)
# ----------------------------------------------------------------
# Create BMI and drop the original columns
for df in [train_df, test_df]:
    # Check for division by zero, although height shouldn't be 0
    df['BMI'] = df['Weight'] / (df['Height'] ** 2)

# Define target and features to drop
target_col = 'WeightCategory'
drop_cols = ['id', 'FCVC', 'FAVC', 'Height', 'Weight'] # Drop originals

numerical_cols = ['Age','BMI','NCP', 'CH2O', 'FAF', 'TUE']

# Define features for One-Hot Encoding (no order)
nominal_cols = ['MTRANS']

# Define features for Binary Encoding (0/1)
# OrdinalEncoder handles this perfectly.
binary_cols = ['Gender', 'family_history_with_overweight', 'SCC', 'SMOKE']
# Define features for Ordinal Encoding (with order)
caec_order = ['no', 'Sometimes', 'Frequently', 'Always']
calc_order = ['no', 'Sometimes', 'Frequently']
```

1.3 Data Visualization

1.3.1 Finding Outliers for each Feature

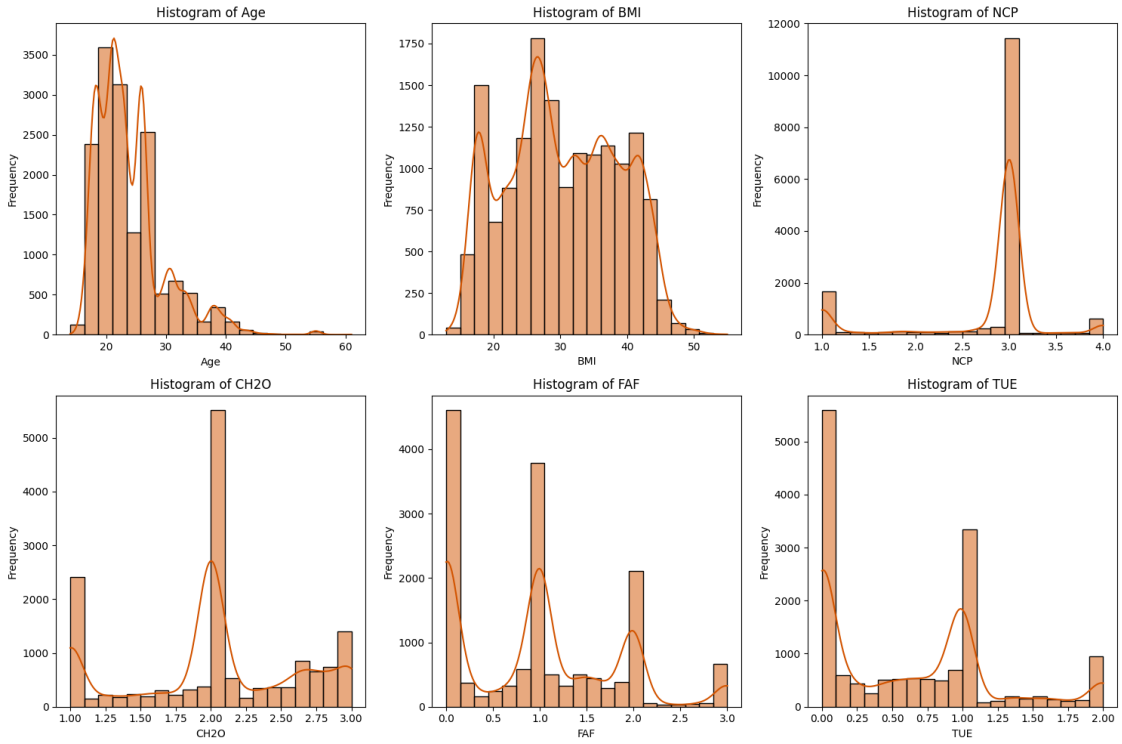
[5]:
```
# Calculate the IQR for each numeric column
Q1 = train_df[numerical_cols].quantile(0.25)
Q3 = train_df[numerical_cols].quantile(0.75)
IQR = Q3 - Q1

# Define lower and upper bounds for outliers
lower_bound = Q1 - 1.5 * IQR
upper_bound = Q3 + 1.5 * IQR
```

```
# Count outliers for each numeric column
outliers_count = ((train_df[numerical_cols] < lower_bound) |␣
 ↪(train_df[numerical_cols] > upper_bound)).sum()

# Display the count of outliers for each column
print("Count of outliers for each column:")
print(outliers_count)
```

```
Count of outliers for each column:
Age      792
BMI        0
NCP     4548
CH2O       0
FAF        0
TUE        0
dtype: int64
```

1.3.2 distribution of various numeric features in the dataset

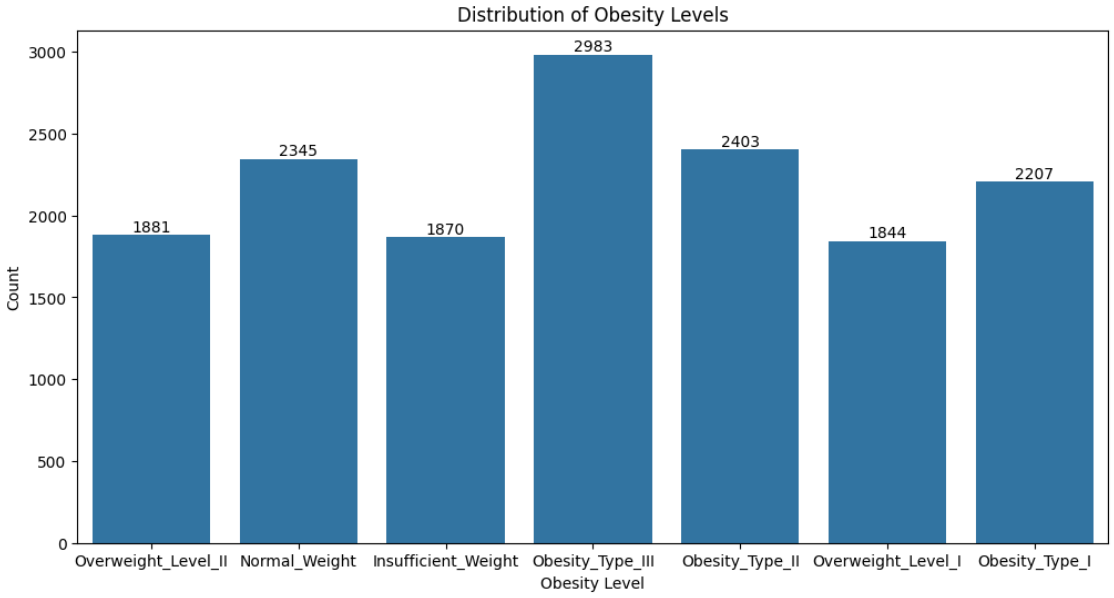
[6]:
```
# Create subplots
num_rows = len(numerical_cols) // 3 + (len(numerical_cols) % 3 > 0)
fig, axes = plt.subplots(num_rows, 3, figsize=(15, 5 * num_rows))
axes = axes.flatten()

# Create histograms for each numeric column
for i, column in enumerate(numerical_cols):
    sns.histplot(train_df[column], kde=True, color='#D35400', bins=20,␣
 ↪ax=axes[i])
    axes[i].set_title(f'Histogram of {column}')
    axes[i].set_xlabel(column)
    axes[i].set_ylabel('Frequency')

# Hide extra subplots
for j in range(len(numerical_cols), len(axes)):
    axes[j].axis('off')

plt.tight_layout()
plt.show()
```



[7]:
```
# Make a fuction that adds data labels for countplots
def add_data_labels(ax):
    """Add data labels to the bars of a countplot."""
    for p in ax.patches:
        ax.annotate(f"{int(p.get_height())}",
                    (p.get_x() + p.get_width() / 2., p.get_height()),
                    ha='center', va='center', fontsize=10, color='black',␣
 ↪xytext=(0, 5),
                    textcoords='offset points')
```

1.3.3 distribution of the target variable

[8]:
```
# Visualize the distribution of the target variable
plt.figure(figsize=(12, 6))
ax = sns.countplot(x='WeightCategory', data=train_df)
add_data_labels(ax)
plt.title('Distribution of Obesity Levels')
plt.xlabel('Obesity Level')
plt.ylabel('Count')
plt.show()
```

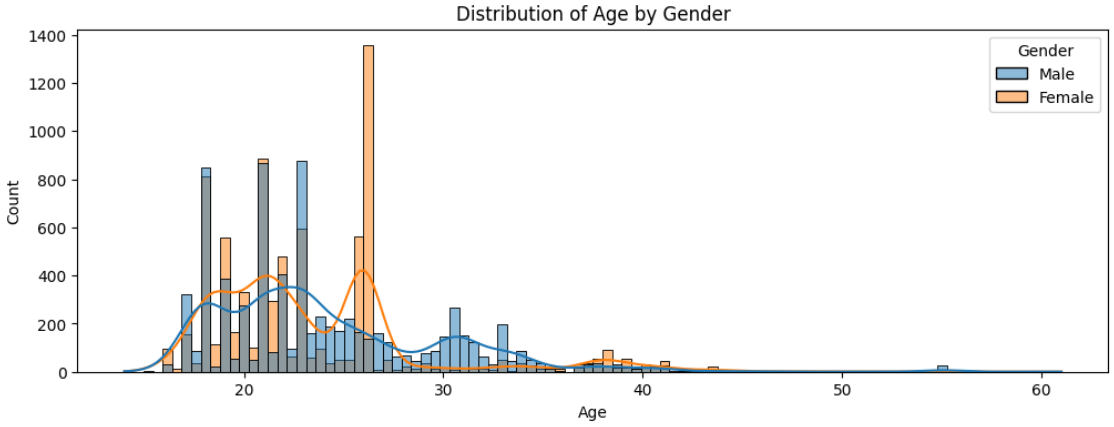


1.3.4 relationship between age and obesity levels

[9]:
```
plt.figure(figsize=(12, 6))
sns.boxplot(x='WeightCategory', y='Age', data=train_df)
plt.title('Relationship between Age and Obesity Levels')
plt.xlabel('Obesity Level')
plt.ylabel('Age')
plt.show()
```

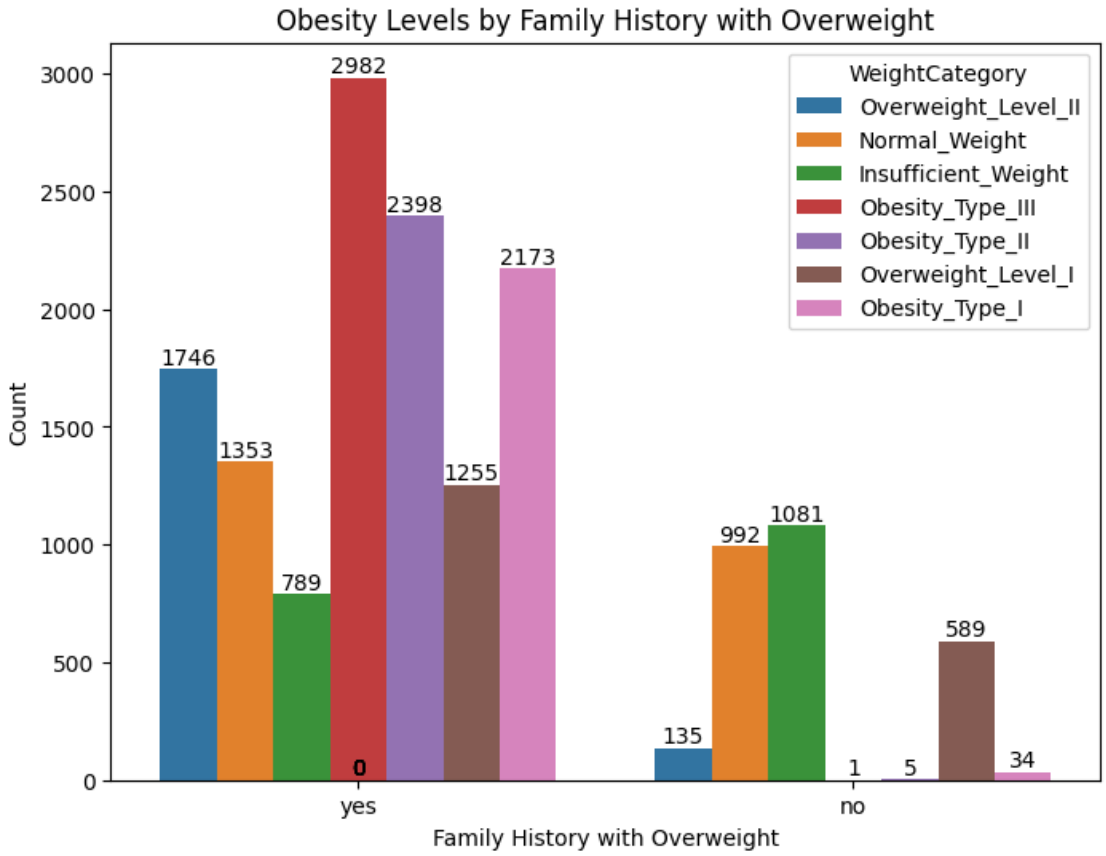
1.3.5 Distribution of Age by Gender

[10]:
```
plt.figure(figsize=(12, 4))
sns.histplot(data=train_df, x='Age', hue='Gender', kde=True)
# add_data_labels(ax)
plt.title('Distribution of Age by Gender')
plt.xlabel('Age')
plt.ylabel('Count')
plt.show()
```



1.3.6 differences in obesity levels based on family history with overweight

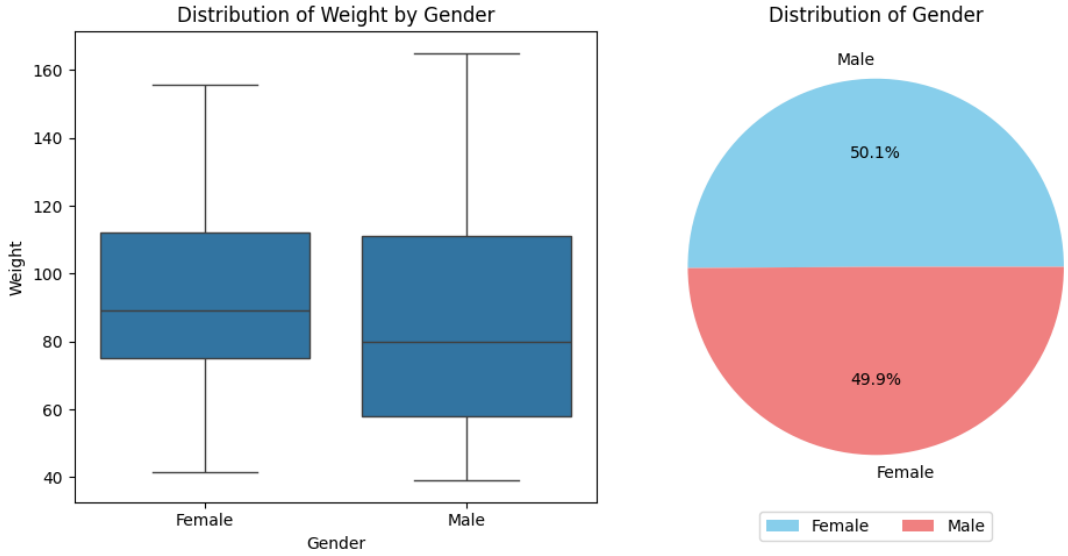
[11]:
```
plt.figure(figsize=(8, 6))
ax = sns.countplot(x='family_history_with_overweight', hue='WeightCategory',␣
↪data=train_df)
add_data_labels(ax)
plt.title('Obesity Levels by Family History with Overweight')
plt.xlabel('Family History with Overweight')
plt.ylabel('Count')
plt.show()
```



1.3.7 Distribution of Weight by Gender

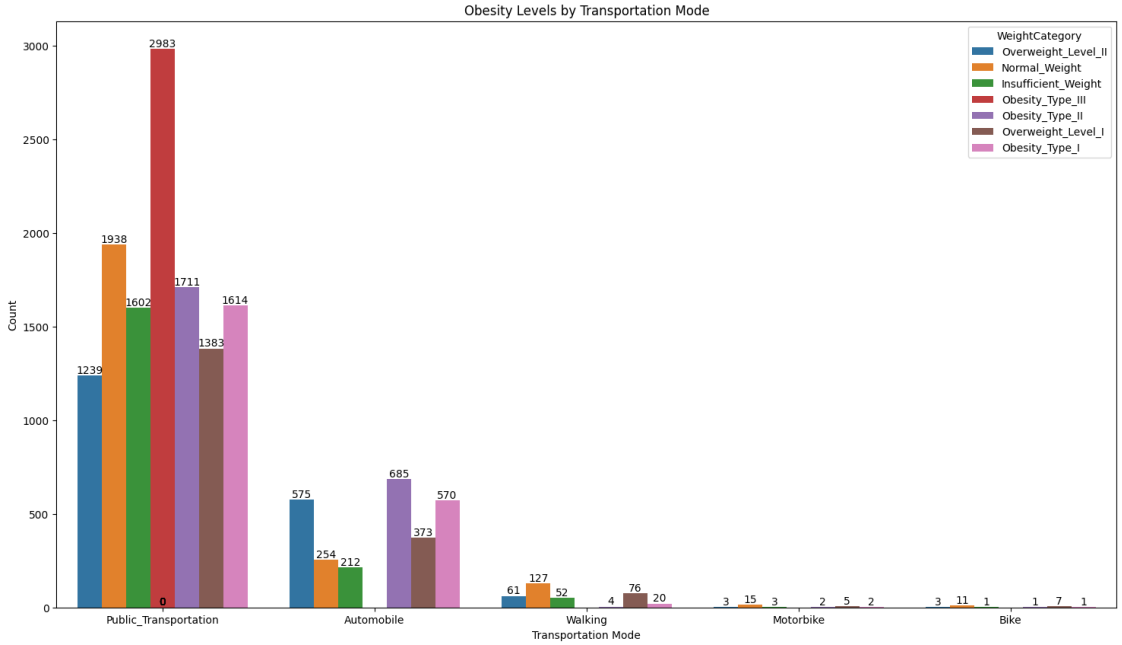
[12]:
```
# Create subplots
fig, axes = plt.subplots(1, 2, figsize=(10, 5))

# Plot 1: Boxplot
sns.boxplot(x='Gender', y='Weight', data=train_df, ax=axes[0])
axes[0].set_title('Distribution of Weight by Gender')
axes[0].set_xlabel('Gender')
axes[0].set_ylabel('Weight')
axes[0].set_xticks(ticks=[0, 1])
axes[0].set_xticklabels(['Female', 'Male'])

# Plot 2: Pie chart
train_df['Gender'].value_counts().plot(kind='pie', autopct='%1.1f%%',␣
 ↪colors=['skyblue', 'lightcoral'], ax=axes[1])
axes[1].set_title('Distribution of Gender')
axes[1].set_ylabel('')
```

```
# Move legend to bottom center with 2 columns
axes[1].legend(labels=['Female', 'Male'], loc='lower center', bbox_to_anchor=(0.
↪5, -0.1), ncol=2)

plt.tight_layout()
plt.show()
```



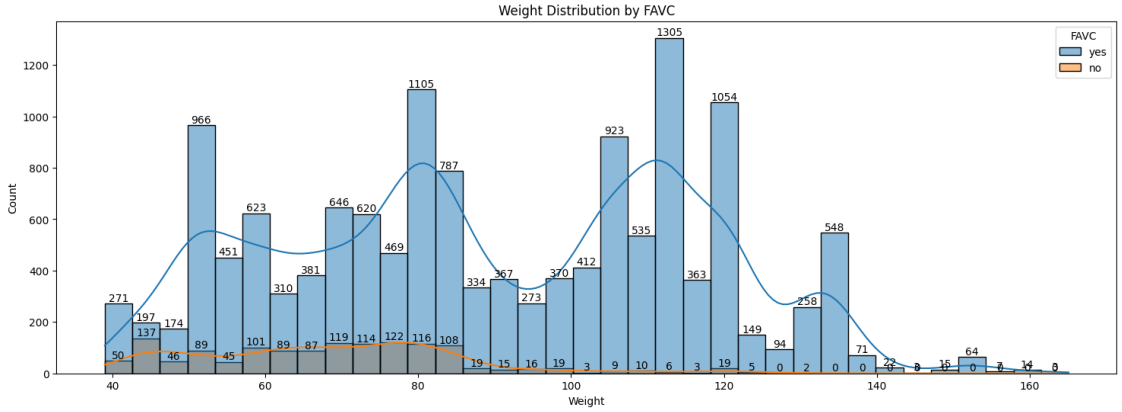
1.3.8 difference in obesity levels based on transportation mode (MTRANS)

[13]:
```
plt.figure(figsize=(18, 10))
ax = sns.countplot(x='MTRANS', hue='WeightCategory', data=train_df)
add_data_labels(ax)
plt.title('Obesity Levels by Transportation Mode')
plt.xlabel('Transportation Mode')
plt.ylabel('Count')
plt.show()
```



1.3.9 differences in weight distribution between individuals who frequently consume high-caloric food (FAVC) and those who do not

[14]:
```
plt.figure(figsize=(18, 6))
ax = sns.histplot(data=train_df, x='Weight', hue='FAVC', kde=True)
add_data_labels(ax)
plt.title('Weight Distribution by FAVC')
plt.xlabel('Weight')
plt.ylabel('Count')
plt.show()
```



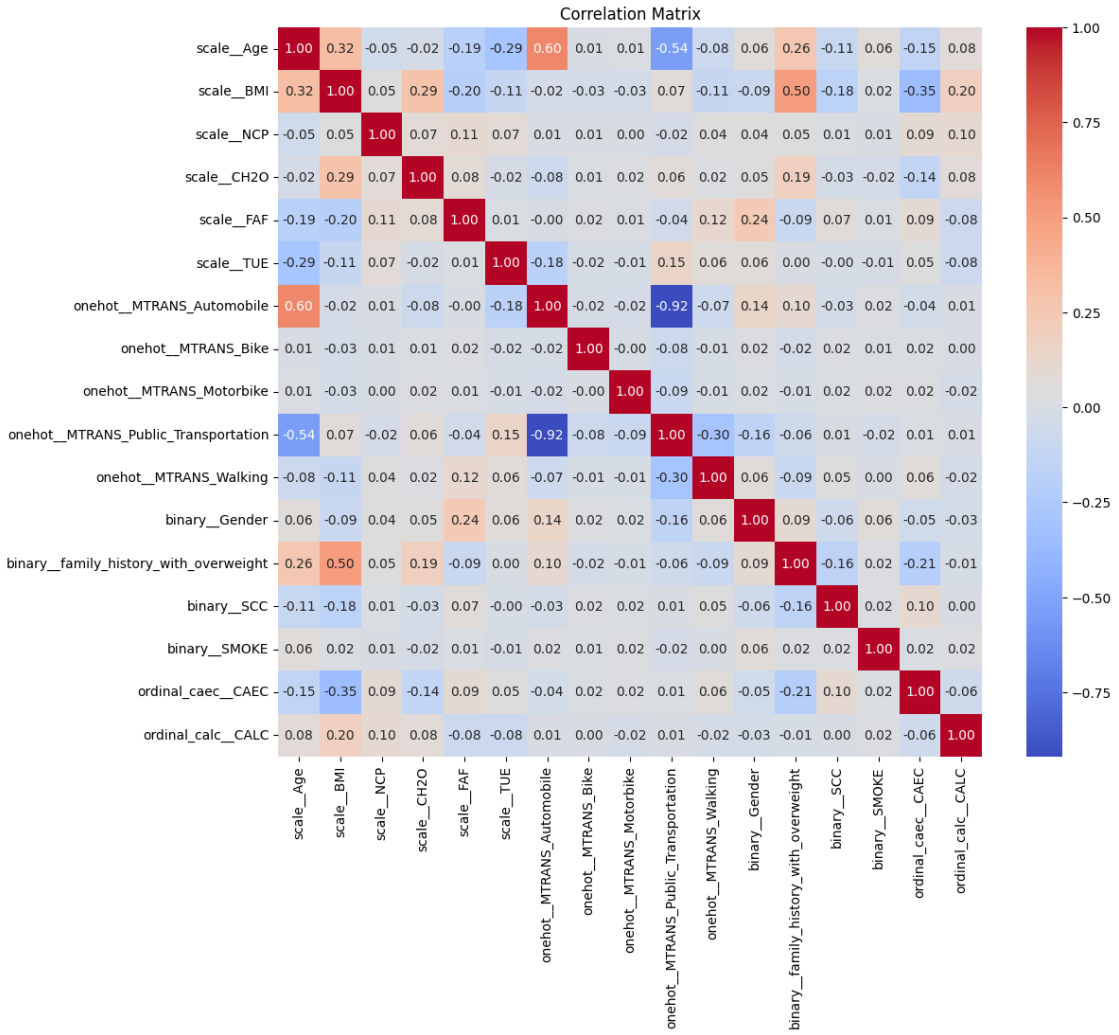
1.4 Data Preprocessing

[15]:
```
# ------------------------------------------------------------------
# STEP 3: Create the Preprocessing Pipeline (ColumnTransformer)
# ------------------------------------------------------------------

# This 'preprocessor' is for your features (X)
preprocessor = ColumnTransformer(
    transformers=[
        ('scale', StandardScaler(), numerical_cols),
        ('onehot', OneHotEncoder(handle_unknown='ignore', sparse_output=False),␣
 ↪nominal_cols),
        ('binary', OrdinalEncoder(), binary_cols),
        ('ordinal_caec', OrdinalEncoder(categories=[caec_order],␣
 ↪handle_unknown='use_encoded_value', unknown_value=-1), ['CAEC']),
        ('ordinal_calc', OrdinalEncoder(categories=[calc_order],␣
 ↪handle_unknown='use_encoded_value', unknown_value=-1), ['CALC'])
    ],
    remainder='drop' # Drops any columns we didn't specify (like 'id')
)

# ------------------------------------------------------------------
# STEP 4: Apply the Pipeline to your Data
# ------------------------------------------------------------------

# Separate features (X) and target (y)
X_train = train_df.drop(columns=[target_col] + drop_cols, errors='ignore')
y_train = train_df[target_col]

# The test set from the competition might not have the target column
if target_col in test_df.columns:
    X_test = test_df.drop(columns=[target_col] + drop_cols, errors='ignore')
    y_test = test_df[target_col] # If you have a local validation set
else:
    X_test = test_df.drop(columns=drop_cols, errors='ignore')

# Fit the preprocessor on TRAINING data and transform BOTH
X_train_processed = preprocessor.fit_transform(X_train)
X_test_processed = preprocessor.transform(X_test)

# ------------------------------------------------------------------
# STEP 5: Encode the Target Variable (y)
# ------------------------------------------------------------------
le2 = LabelEncoder()
y_train_encoded = le2.fit_transform(y_train)
feature_names = preprocessor.get_feature_names_out()
```

```
# Convert back to a DataFrame (optional, but good for inspection)
X_train_final = pd.DataFrame(X_train_processed, columns=feature_names)
X_test_final = pd.DataFrame(X_test_processed, columns=feature_names)

print("Preprocessing Complete!")
print("Final training data shape:", X_train_final.shape)
print("Example feature names:", feature_names)
```

```
Preprocessing Complete!
Final training data shape: (15533, 17)
Example feature names: ['scale__Age' 'scale__BMI' 'scale__NCP' 'scale__CH2O'
'scale__FAF'
 'scale__TUE' 'onehot__MTRANS_Automobile' 'onehot__MTRANS_Bike'
 'onehot__MTRANS_Motorbike' 'onehot__MTRANS_Public_Transportation'
 'onehot__MTRANS_Walking' 'binary__Gender'
 'binary__family_history_with_overweight' 'binary__SCC' 'binary__SMOKE'
 'ordinal_caec__CAEC' 'ordinal_calc__CALC']
```

[16]:
```
# lets visualize correlations
plt.figure(figsize=(12,10))
correlation_matrix = X_train_final.corr()
sns.heatmap(correlation_matrix, annot=True, fmt=".2f", cmap='coolwarm')
plt.title("Correlation Matrix")
plt.show()
```



[17]:
```
print(X_train_final.head())
print(X_test_final.head())
```

```
   scale__Age  scale__BMI  scale__NCP  scale__CH2O  scale__FAF  scale__TUE  \
0    0.110667   -0.235071    0.315486     1.211010   -1.167485    0.602221
1   -1.027075   -0.816880    0.339130    -0.045459    0.027524    0.641290
2   -1.027075   -1.574034   -1.909206    -0.192933   -0.132554    1.759822
3   -0.505665    1.760978    0.339130    -0.581796    0.586624    0.276295
4    1.381740   -0.555043   -1.116801    -0.078619    1.184260    0.527908

   onehot__MTRANS_Automobile  onehot__MTRANS_Bike  onehot__MTRANS_Motorbike  \
0                        0.0                  0.0                       0.0
1                        1.0                  0.0                       0.0
2                        0.0                  0.0                       0.0
3                        0.0                  0.0                       0.0
4                        0.0                  0.0                       0.0
```

```
   onehot__MTRANS_Public_Transportation  onehot__MTRANS_Walking  \
0                                   1.0                     0.0
1                                   0.0                     0.0
2                                   1.0                     0.0
3                                   1.0                     0.0
4                                   1.0                     0.0

   binary__Gender  binary__family_history_with_overweight  binary__SCC  \
0             1.0                                    1.0          0.0
1             0.0                                    1.0          0.0
2             0.0                                    1.0          0.0
3             0.0                                    1.0          0.0
4             1.0                                    1.0          0.0

   binary__SMOKE  ordinal_caec__CAEC  ordinal_calc__CALC
0            0.0                 1.0                 1.0
1            0.0                 2.0                 0.0
2            0.0                 1.0                 0.0
3            0.0                 1.0                 1.0
4            0.0                 1.0                 1.0
   scale__Age  scale__BMI  scale__NCP  scale__CH2O  scale__FAF  scale__TUE  \
0   -0.849222    1.643628    0.339130    -0.033368    0.584315    0.331153
1   -0.396292   -0.506576    0.339130    -0.045459    0.718028    2.079095
2   -0.270402   -0.366881   -0.056315    -0.324186   -0.628525   -1.019279
3    1.253777    0.976798    0.339130     0.192100   -0.315771   -0.853143
4   -1.027075   -0.830761    0.339130    -0.045459    0.027524    0.641290

   onehot__MTRANS_Automobile  onehot__MTRANS_Bike  onehot__MTRANS_Motorbike  \
0                        0.0                  0.0                       0.0
1                        0.0                  0.0                       0.0
2                        0.0                  0.0                       0.0
3                        1.0                  0.0                       0.0
4                        0.0                  0.0                       0.0

   onehot__MTRANS_Public_Transportation  onehot__MTRANS_Walking  \
0                                   1.0                     0.0
1                                   1.0                     0.0
2                                   1.0                     0.0
3                                   0.0                     0.0
4                                   1.0                     0.0

   binary__Gender  binary__family_history_with_overweight  binary__SCC  \
0             0.0                                    1.0          0.0
1             0.0                                    1.0          0.0
2             1.0                                    1.0          0.0
3             1.0                                    1.0          0.0
4             0.0                                    0.0          0.0
```

```
   binary__SMOKE  ordinal_caec__CAEC  ordinal_calc__CALC
0            0.0                 1.0                 1.0
1            0.0                 1.0                 1.0
2            0.0                 1.0                 1.0
3            0.0                 1.0                 1.0
4            0.0                 1.0                 0.0
```

1.5 Model Definition and Train, Test Splits

[18]:
```
XGB = XGBClassifier()

X_train, X_val, y_train, y_val = train_test_split(X_train_final,␣
 ↪y_train_encoded, test_size=0.2, random_state=42)
```

[19]:
```
# XGB.fit(X_train, y_train)

# # training accuracy
# y_train_pred = XGB.predict(X_train)
# print("Training Predictions:", y_train_pred)
# train_accuracy = accuracy_score(y_train, y_train_pred)
# print(f"Training Accuracy: {train_accuracy*100:.2f}%")

# #validation accuracy
# y_val_pred = XGB.predict(X_val)
# print("Validation Predictions:", y_val_pred)
# val_accuracy = accuracy_score(y_val, y_val_pred)
# print(f"Validation Accuracy: {val_accuracy*100:.2f}%")
```

1.6 HyperParameter Tuning

[20]:
```
print("--- Tuning n_estimators and learning_rate ---")

param_grid_1 = {
    'learning_rate': [0.025, 0.05, 0.1, 0.2],
    'n_estimators': [400, 800, 1000, 1200]
}

grid_search_1 = GridSearchCV(estimator=XGB, param_grid=param_grid_1,
                             scoring='accuracy', n_jobs=-1, cv=5, verbose=1)

grid_search_1.fit(X_train, y_train)

print("Best Parameters (Step 1):", grid_search_1.best_params_)
# Store the best parameters to use in the next steps
best_params = grid_search_1.best_params_
```

```
--- Tuning n_estimators and learning_rate ---
Fitting 5 folds for each of 16 candidates, totalling 80 fits

Best Parameters (Step 1): {'learning_rate': 0.05, 'n_estimators': 400}
```

[21]:
```python
print("\n--- Tuning max_depth and min_child_weight ---")

# Update the classifier with the best parameters found so far
xgb_clf_2 = XGBClassifier(
    objective='binary:logistic',
    eval_metric='logloss',
    use_label_encoder=False,
    random_state=42,
    learning_rate=best_params['learning_rate'],
    n_estimators=best_params['n_estimators']
)

param_grid_2 = {
    'max_depth': [3, 4, 5],
    'min_child_weight': [3, 4, 5]
}

grid_search_2 = GridSearchCV(estimator=xgb_clf_2, param_grid=param_grid_2,
                             scoring='accuracy', n_jobs=-1, cv=5, verbose=1)

grid_search_2.fit(X_train, y_train)

print("Best Parameters (Step 2):", grid_search_2.best_params_)
# Update our best parameters dictionary
best_params.update(grid_search_2.best_params_)
```

```
--- Tuning max_depth and min_child_weight ---
Fitting 5 folds for each of 9 candidates, totalling 45 fits
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:11] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:11] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:11] WARNING:
```

```
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
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  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
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/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:19] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:19] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:19] WARNING:
```

```
/workspace/src/learner.cc:738:
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packages/xgboost/training.py:183: UserWarning: [22:16:19] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:20] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:20] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

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packages/xgboost/training.py:183: UserWarning: [22:16:20] WARNING:
/workspace/src/learner.cc:738:
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/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

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/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
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/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:24] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:24] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:24] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

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/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
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/workspace/src/learner.cc:738:
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/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:24] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:25] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:25] WARNING:
```

```
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
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/workspace/src/learner.cc:738:
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/workspace/src/learner.cc:738:
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/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:29] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
Best Parameters (Step 2): {'max_depth': 5, 'min_child_weight': 5}
```

[22]:
```python
print("\n--- Tuning subsample and colsample_bytree ---")

xgb_clf_3 = XGBClassifier(
    objective='binary:logistic',
    eval_metric='logloss',
    use_label_encoder=False,
    random_state=42,
    **best_params # Pass all best params found so far
)

param_grid_3 = {
    'subsample': [0.8, 0.9, 1.0],
    'colsample_bytree': [0.9, 1.0]
}

grid_search_3 = GridSearchCV(estimator=xgb_clf_3, param_grid=param_grid_3,
                             scoring='accuracy', n_jobs=-1, cv=5, verbose=1)

grid_search_3.fit(X_train, y_train)

print("Best Parameters (Step 3):", grid_search_3.best_params_)
best_params.update(grid_search_3.best_params_)
```

```
--- Tuning subsample and colsample_bytree ---
Fitting 5 folds for each of 6 candidates, totalling 30 fits
```

```
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:31] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
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/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:36] WARNING:
/workspace/src/learner.cc:738:
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/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
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/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:42] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
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Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:42] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:42] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:45] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)

Best Parameters (Step 3): {'colsample_bytree': 1.0, 'subsample': 0.8}
```

[23]:
```python
print("\n--- Tuning gamma and reg_lambda ---")

xgb_clf_4 = XGBClassifier(
    objective='binary:logistic',
    eval_metric='logloss',
    use_label_encoder=False,
    random_state=42,
    **best_params
)

param_grid_4 = {
    'gamma': [0, 0.1, 0.2, 0.3, 0.4, 0.5],
}

grid_search_4 = GridSearchCV(estimator=xgb_clf_4, param_grid=param_grid_4,
                             scoring='accuracy', n_jobs=-1, cv=5, verbose=1)

grid_search_4.fit(X_train, y_train)

print("Best Parameters (Step 4):", grid_search_4.best_params_)
best_params.update(grid_search_4.best_params_)
```

```
--- Tuning gamma and reg_lambda ---
Fitting 5 folds for each of 6 candidates, totalling 30 fits
```

```
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:46] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:46] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:46] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:46] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.
```

```
  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:46] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:46] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:46] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:46] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:46] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:46] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:46] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:46] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.
```

```
  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:52] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:52] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:52] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:52] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:52] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:52] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:52] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:52] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.
```

```
  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:52] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:53] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:53] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:53] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:57] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:57] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:57] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:58] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.
```

```
  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:58] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:16:58] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:17:01] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
Best Parameters (Step 4): {'gamma': 0}
```

1.7 Final Model Training

[24]:
```
# Create the final, tuned model
final_xgb_clf = XGBClassifier(
    objective='binary:logistic',
    eval_metric='logloss',
    use_label_encoder=False,
    random_state=42,
    **best_params
)

# Train on the full training data
final_xgb_clf.fit(X_train_final, y_train_encoded)
```

```
/home/vansh-doshi/scraping_JD/.venv/lib/python3.12/site-
packages/xgboost/training.py:183: UserWarning: [22:17:03] WARNING:
/workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
```

[24]:
```
XGBClassifier(base_score=None, booster=None, callbacks=None,
              colsample_bylevel=None, colsample_bynode=None,
              colsample_bytree=1.0, device=None, early_stopping_rounds=None,
              enable_categorical=False, eval_metric='logloss',
```

```
feature_types=None, feature_weights=None, gamma=0,
grow_policy=None, importance_type=None,
interaction_constraints=None, learning_rate=0.05, max_bin=None,
max_cat_threshold=None, max_cat_to_onehot=None,
max_delta_step=None, max_depth=5, max_leaves=None,
min_child_weight=5, missing=nan, monotone_constraints=None,
multi_strategy=None, n_estimators=400, n_jobs=None,
num_parallel_tree=None, …)
```

[25]:
```
# # training accuracy
# y_train_pred = final_xgb_clf.predict(X_train)
# print("Training Predictions:", y_train_pred)
# train_accuracy = accuracy_score(y_train, y_train_pred)
# print(f"Training Accuracy: {train_accuracy*100:.2f}%")

# #validation accuracy
# y_val_pred = final_xgb_clf.predict(X_val)
# print("Validation Predictions:", y_val_pred)
# val_accuracy = accuracy_score(y_val, y_val_pred)
# print(f"Validation Accuracy: {val_accuracy*100:.2f}%")
```

1.8 Predictions and Making the Submission file for Kaggle Submission

[26]:
```
# XGB.fit(X, y)
preds = final_xgb_clf.predict(X_test_final)
```

[27]:
```
final_preds = le2.inverse_transform(preds)
print(final_preds)
```

```
['Obesity_Type_III' 'Overweight_Level_I' 'Overweight_Level_II' …
 'Obesity_Type_I' 'Overweight_Level_II' 'Obesity_Type_II']
```

[28]:
```
print(len(final_preds))
print(len(test_df['id']))
```

```
5225
5225
```

[29]:
```
with open("submission.csv", "w") as f:
    f.write("id,WeightCategory\n")
    for i in range(len(final_preds)):
        f.write(f"{test_df['id'][i]},{final_preds[i]}\n")
```