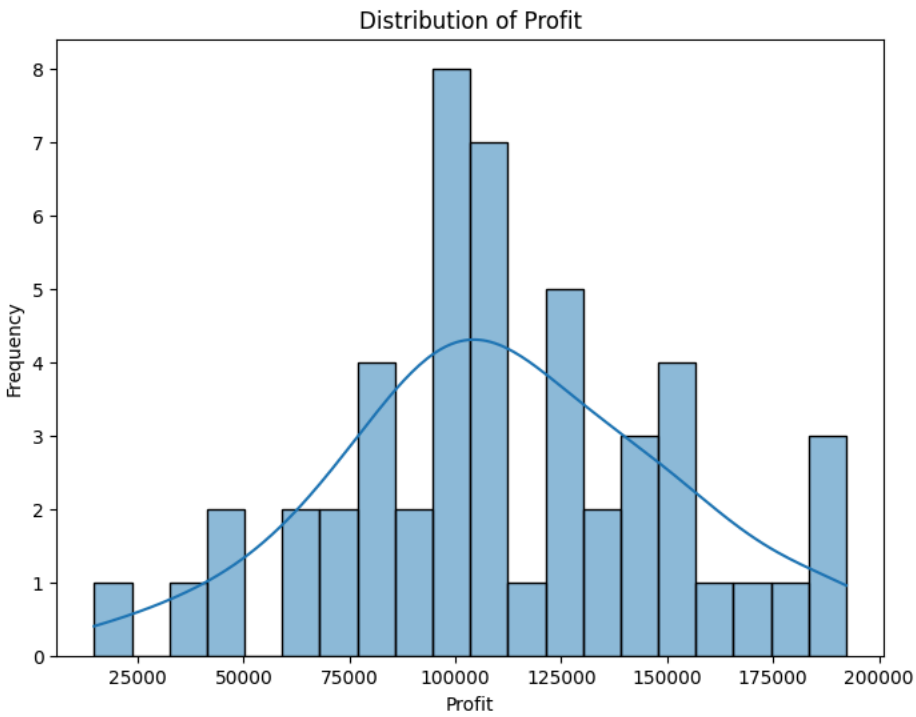
```
import pandas as pd
import xgboost as xgb
from sklearn.model_selection import train_test_split, GridSearchCV
from sklearn.metrics import mean_squared_error
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns


# Step 1: Data Loading, Exploration, and Visualization
data = pd.read_csv("/content/50_Startups.csv")


# Check the first few rows of the dataset
print(data.head())
```

```
    R&D Spend  Administration  Marketing Spend     Profit
0  165349.20       136897.80        471784.10  192261.83
1  162597.70       151377.59        443898.53  191792.06
2  153441.51       101145.55        407934.54  191050.39
3  144372.41       118671.85        383199.62  182901.99
4  142107.34        91391.77        366168.42  166187.94
```

```
# Check for missing values
print(data.isnull().sum())
```

```
R&D Spend          0
Administration     0
Marketing Spend    0
Profit             0
dtype: int64
```

```
# Visualize the distribution of the target variable
plt.figure(figsize=(8, 6))
sns.histplot(data['Profit'], bins=20, kde=True)
plt.title('Distribution of Profit')
plt.xlabel('Profit')
plt.ylabel('Frequency')
plt.show()
```




```
# Separate features (X) and target variable (y)
X = data[['R&D Spend', 'Administration', 'Marketing Spend']]
y = data['Profit']
```

```
# Step 2: Model Construction with Hyperparameter Tuning
# Split data into train and test sets
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)

# Set the hyperparameter grid
param_grid = {
    'learning_rate': [0.1, 0.5, 1],
    'max_depth': [3, 5, 7],
    'n_estimators': [10, 50, 100]
}

# Define the model
model = xgb.XGBRegressor()

# Use GridSearchCV to tune the hyperparameters
grid_search = GridSearchCV(model, param_grid, cv=5, scoring='neg_mean_squared_error', verbose=2)
grid_search.fit(X_train, y_train)
```

```
Fitting 5 folds for each of 27 candidates, totalling 135 fits
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```

```
▸ GridSearchCV
▸ estimator: XGBRegressor
    ▸ XGBRegressor
```

```
# Print the best hyperparameters
print(f'Best learning rate: {grid_search.best_params_["learning_rate"]}')
print(f'Best max depth: {grid_search.best_params_["max_depth"]}')
print(f'Best number of estimators: {grid_search.best_params_["n_estimators"]}')
```

```
Best learning rate: 0.5
Best max depth: 3
Best number of estimators: 100
```

```
# Train the final model with the best parameters
final_model = xgb.XGBRegressor(**grid_search.best_params_)
final_model.fit(X_train, y_train)
```

```
▾ XGBRegressor
XGBRegressor(base_score=None, booster=None, callbacks=None,
             colsample_bylevel=None, colsample_bynode=None,
             colsample_bytree=None, device=None, early_stopping_rounds=None,
             enable_categorical=False, eval_metric=None, feature_types=None,
             gamma=None, grow_policy=None, importance_type=None,
             interaction_constraints=None, learning_rate=0.5, max_bin=None,
             max_cat_threshold=None, max_cat_to_onehot=None,
             max_delta_step=None, max_depth=3, max_leaves=None,
             min_child_weight=None, missing=nan, monotone_constraints=None,
             multi_strategy=None, n_estimators=100, n_jobs=None,
             num_parallel_tree=None, random_state=None, ...)
```

```
# Make predictions on the test set
y_pred = final_model.predict(X_test)
```