

# Kaggle Playground

## Problem Statement / Real World Implementations

### 1. Importing Libraries

```
In [1]: # Core Data Science Libraries
import numpy as np
import pandas as pd
import warnings

# Visualization Libraries
import plotly.express as px
import matplotlib.pyplot as plt
import seaborn as sns
import plotly.graph_objects as go
from plotly.subplots import make_subplots

# Scikit-Learn for Preprocessing and Modeling
from sklearn.model_selection import KFold, train_test_split
from sklearn.preprocessing import OrdinalEncoder, StandardScaler
from sklearn.metrics import mean_squared_error, mean_absolute_error, r2_score

# Machine Learning Models
from xgboost import XGBRegressor
from lightgbm import LGBMRegressor

# Hyperparameter Tuning
import optuna

# Notebook settings
warnings.filterwarnings('ignore')
pd.set_option('display.max_columns', None)
```

### 2. Loading Dataset

```
In [2]: # Define file paths
TRAIN_PATH = "/kaggle/input/playground-series-s5e11/train.csv"
TEST_PATH = "/kaggle/input/playground-series-s5e11/test.csv"
SUBMISSION_PATH = "/kaggle/input/playground-series-s5e11/sample_submission.csv"

# Load the datasets into pandas DataFrames
train_df = pd.read_csv(TRAIN_PATH)
test_df = pd.read_csv(TEST_PATH)
submission_df = pd.read_csv(SUBMISSION_PATH)
```

```
In [3]: print("Train shape:", train_df.shape)
print("Test shape:", test_df.shape)
```

Train shape: (593994, 13)  
Test shape: (254569, 12)

```
In [4]: df=train_df
df.head(5)
```

```
Out[4]:
```

	id	annual_income	debt_to_income_ratio	credit_score	loan_amount	interest_rate	gend
0	0	29367.99	0.084	736	2528.42	13.67	Fema
1	1	22108.02	0.166	636	4593.10	12.92	Ma
2	2	49566.20	0.097	694	17005.15	9.76	Ma
3	3	46858.25	0.065	533	4682.48	16.10	Fema
4	4	25496.70	0.053	665	12184.43	10.21	Ma

```
In [5]: print(df["gender"].unique())
print(df["marital_status"].unique())
print(df["education_level"].unique())
print(df["employment_status"].unique())
print(df["loan_purpose"].unique())
print(df["grade_subgrade"].unique())

['Female' 'Male' 'Other']
['Single' 'Married' 'Divorced' 'Widowed']
['High School' 'Master's' 'Bachelor's' 'PhD' 'Other']
['Self-employed' 'Employed' 'Unemployed' 'Retired' 'Student']
['Other' 'Debt consolidation' 'Home' 'Education' 'Vacation' 'Car'
 'Medical' 'Business']
['C3' 'D3' 'C5' 'F1' 'D1' 'D5' 'C2' 'C1' 'F5' 'D4' 'C4' 'D2' 'E5' 'B1'
 'B2' 'F4' 'A4' 'E1' 'F2' 'B4' 'E4' 'B3' 'E3' 'B5' 'E2' 'F3' 'A5' 'A3'
 'A1' 'A2']
```

```
In [6]: df.isna().sum()
```

```
Out[6]: id                0
annual_income            0
debt_to_income_ratio     0
credit_score             0
loan_amount              0
interest_rate            0
gender                   0
marital_status           0
education_level          0
employment_status        0
loan_purpose               0
grade_subgrade           0
loan_paid_back           0
dtype: int64
```

```
In [7]: df.head()
```

Out[7]:

	id	annual_income	debt_to_income_ratio	credit_score	loan_amount	interest_rate	gend
0	0	29367.99	0.084	736	2528.42	13.67	Fema
1	1	22108.02	0.166	636	4593.10	12.92	Ma
2	2	49566.20	0.097	694	17005.15	9.76	Ma
3	3	46858.25	0.065	533	4682.48	16.10	Fema
4	4	25496.70	0.053	665	12184.43	10.21	Ma

## 4. EDA

```
In [8]: # Select only numeric columns for correlation matrix
numerical_cols = train_df.select_dtypes(include=np.number).columns.tolist()
numerical_cols.remove('id')
numerical_cols.remove('loan_paid_back')

numeric_df = train_df[numerical_cols + ['loan_paid_back']]
corr_matrix = numeric_df.corr()

# Create the interactive heatmap
fig = go.Figure(data=go.Heatmap(
    z=corr_matrix.values,
    x=corr_matrix.columns,
    y=corr_matrix.columns,
    colorscale='RdBu_r',
    zmin=-1, zmax=1,
    text=corr_matrix.round(2).values,
    texttemplate="%{text}",
    hoverongaps=False))

fig.update_layout(
    title='Correlation Heatmap of Numerical Features',
    width=800, height=800
)
fig.show()
```

### 3. Normalization of data

```
In [9]: # Save the test IDs now, before we drop the 'id' column
test_ids = test_df['id']
# -----

# Drop 'id' from both, as it's not a feature
train_df = train_df.drop('id', axis=1)
test_df = test_df.drop('id', axis=1)
```

In [10]:

```

def create_financial_features(df):
    """
    Creates new financial features from the existing columns.
    """
    # Create monthly_income
    df['monthly_income'] = df['annual_income'] / 12

    # Create total_monthly_debt
    df['total_monthly_debt'] = df['debt_to_income_ratio'] * df['monthly_income']

    # Create available_income (disposable income)
    df['available_income'] = df['monthly_income'] - df['total_monthly_debt']

    # Create loan_to_income_ratio
    df['loan_to_income_ratio'] = df['loan_amount'] / df['annual_income']

    # Create loan_to_available_income
    df['loan_to_available_income'] = df['loan_amount'] / df['available_income']

    # Clean up any 'inf' values created by dividing by zero
    df.replace([np.inf, -np.inf], np.nan, inplace=True)

    # Drop the original, redundant columns
    cols_to_drop = ['annual_income', 'debt_to_income_ratio']
    df = df.drop(columns=cols_to_drop)

    return df

print("Creating financial features for train_df...")
train_df = create_financial_features(train_df)
print("Creating financial features for test_df...")
test_df = create_financial_features(test_df)

```

Creating financial features for train\_df...

Creating financial features for test\_df...

```

In [11]: def process_and_encode_features(df_train, df_test):
    """
    Applies binning, logical ordinal mapping, and
    ordinal encoding to both train and test sets.

    *** CORRECTED VERSION: Does NOT fill NaNs ***
    """
    # Save target and combine for consistent processing
    train_target = df_train['loan_paid_back']
    df_train = df_train.drop('loan_paid_back', axis=1)

    df_train['source'] = 'train'
    df_test['source'] = 'test'
    combined_df = pd.concat([df_train, df_test], ignore_index=True)

    # --- 1. Bin Credit Score ---
    score_bins = [300, 579, 669, 739, 799, 850]
    score_labels = ['Poor', 'Fair', 'Good', 'Very Good', 'Excellent']
    combined_df['credit_score_bin'] = pd.cut(combined_df['credit_score'],
                                             bins=score_bins,
                                             labels=score_labels,
                                             include_lowest=True)

    # --- 2. Logical Ordinal Mapping ---

```

```

education_map = {
    'Other': 0, 'High School': 1, 'Bachelor\'s': 2, 'Master\'s': 3, 'PhD': 4
}
grades = ['A', 'B', 'C', 'D', 'E', 'F', 'G']
subgrades = ['1', '2', '3', '4', '5']
grade_map = {g + s: i for i, (g, s) in enumerate((g, s) for g in grades for s in subgrades)}

combined_df['education_level_ordinal'] = combined_df['education_level'].map(education_map)
combined_df['grade_subgrade_ordinal'] = combined_df['grade_subgrade'].map(grade_map)

# --- 3. Ordinal Encode Remaining Categoricals ---
categorical_cols = [
    'gender', 'marital_status', 'employment_status',
    'loan_purpose', 'credit_score_bin'
]

encoder = OrdinalEncoder(handle_unknown='use_encoded_value', unknown_value=-1)
combined_df['credit_score_bin'] = combined_df['credit_score_bin'].astype(str)
combined_df[categorical_cols] = encoder.fit_transform(combined_df[categorical_cols])

# --- 4. HANDLE NaNs ---
# We will let the tree models handle NaNs in 'loan_to_available_income'
# But we should still fill 'education_level_ordinal' as it's an encoding
if combined_df['education_level_ordinal'].isnull().any():
    mode_val = combined_df['education_level_ordinal'].mode()[0]
    combined_df['education_level_ordinal'] = combined_df['education_level_ordinal'].fillna(mode_val)

# --- 5. Drop old columns and split back ---
cols_to_drop = ['credit_score', 'education_level', 'grade_subgrade']
combined_df = combined_df.drop(columns=cols_to_drop)

train_processed = combined_df[combined_df['source'] == 'train'].drop('source', axis=1)
test_processed = combined_df[combined_df['source'] == 'test'].drop('source', axis=1)

# Add target back
train_processed['loan_paid_back'] = train_target

return train_processed, test_processed

# --- Re-run the processing ---
print("Processing and encoding all features (letting trees handle NaNs)...")
train_processed, test_processed = process_and_encode_features(train_df, test_df)
print("Processing complete.")

```

Processing and encoding all features (letting trees handle NaNs)...

Processing complete.

In [12]: df.head(5)

Out[12]:

	id	annual_income	debt_to_income_ratio	credit_score	loan_amount	interest_rate	gender
0	0	29367.99	0.084	736	2528.42	13.67	Female
1	1	22108.02	0.166	636	4593.10	12.92	Male
2	2	49566.20	0.097	694	17005.15	9.76	Male
3	3	46858.25	0.065	533	4682.48	16.10	Female
4	4	25496.70	0.053	665	12184.43	10.21	Male

In [13]:

```
# Exclude target column if present
features = train_processed.drop(columns=['loan_paid_back'], errors='ignore')

# 1. Check summary statistics
print("Summary Statistics:\n")
display(features.describe())

# 2. Check for large differences in scale
range_df = features.max() - features.min()
print("\nFeature Ranges:\n")
print(range_df.sort_values(ascending=False))

# 3. Visualize distribution of feature scales
plt.figure(figsize=(10, 6))
sns.boxplot(data=features, orient='h', fliersize=1)
plt.title("Feature Value Distributions (Check for Scale Differences)")
plt.show()

# 4. Correlation check
corr_matrix = features.corr()
high_range_features = range_df[range_df > range_df.mean()].index.tolist()
print(f"\nFeatures with significantly higher ranges: {high_range_features}")

# 5. Quick rule-based decision
if range_df.max() / range_df.min() > 10:
    print("\n✔ Feature scaling is likely necessary (large scale differences detected)")
else:
    print("\n✘ Feature scaling might not be strictly necessary (features on similar scales)")
```

Summary Statistics:

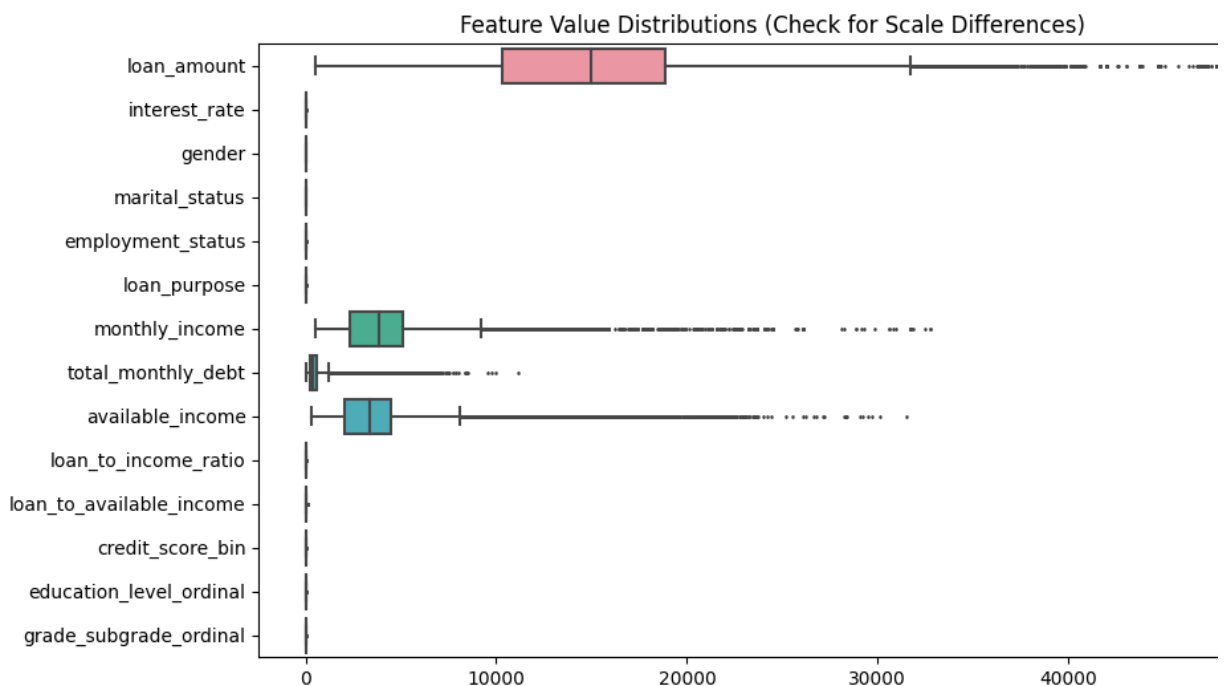
	loan_amount	interest_rate	gender	marital_status	employment_status	loan_purpose
<b>count</b>	593994.000000	593994.000000	593994.000000	593994.000000	593994.000000	593994.000000
<b>mean</b>	15020.297629	12.356345	0.490825	1.472616	0.685438	7.000000
<b>std</b>	6926.530568	2.008959	0.512317	0.585860	1.332355	7.000000
<b>min</b>	500.090000	3.200000	0.000000	0.000000	0.000000	1.000000
<b>25%</b>	10279.620000	10.990000	0.000000	1.000000	0.000000	1.000000
<b>50%</b>	15000.220000	12.370000	0.000000	1.000000	0.000000	1.000000
<b>75%</b>	18858.580000	13.680000	1.000000	2.000000	0.000000	1.000000
<b>max</b>	48959.950000	20.990000	2.000000	3.000000	4.000000	7.000000

Feature Ranges:

```

loan_amount          48459.860000
monthly_income       32281.609167
available_income     31203.185626
total_monthly_debt   11144.399243
loan_to_available_income  94.058593
grade_subgrade_ordinal  29.000000
interest_rate        17.790000
loan_purpose            7.000000
loan_to_income_ratio  5.458652
employment_status     4.000000
credit_score_bin      4.000000
education_level_ordinal  4.000000
marital_status        3.000000
gender                2.000000
dtype: float64

```



Features with significantly higher ranges: ['loan\_amount', 'monthly\_income', 'total\_monthly\_debt', 'available\_income']

✔ Feature scaling is likely necessary (large scale differences detected).



## Train test split

```
In [14]: from sklearn.model_selection import train_test_split
from sklearn.preprocessing import MinMaxScaler, StandardScaler, RobustScaler, Po
import numpy as np

# Use encoded data for model training
X = train_processed.drop("loan_paid_back", axis=1)
y = train_processed["loan_paid_back"]

# Ensure all columns are numeric
X = X.select_dtypes(include=[np.number])

# Train-test split
X_train, X_test, y_train, y_test = train_test_split(
    X, y, test_size=0.2, random_state=42
)

# Choose scaling method
selected_method = 'Standard Scaling'
scaler = StandardScaler()

X_train_scaled = scaler.fit_transform(X_train)
X_test_scaled = scaler.transform(X_test)
```

```
In [15]: import optuna
from sklearn.metrics import mean_squared_error, mean_absolute_error, r2_score
from xgboost import XGBRegressor
from lightgbm import LGBMRegressor

# ✓ Enable GPU for both XGBoost and LightGBM

# --- Hyperparameter tuning for XGBRegressor ---
def objective_xgb(trial):
    param = {
        'tree_method': 'gpu_hist',      # Use GPU histogram algorithm
        'predictor': 'gpu_predictor',   # GPU prediction
        'gpu_id': 0,
        'lambda': trial.suggest_loguniform('lambda', 1e-3, 10.0),
        'alpha': trial.suggest_loguniform('alpha', 1e-3, 10.0),
        'colsample_bytree': trial.suggest_categorical('colsample_bytree', [0.3,
        'subsample': trial.suggest_categorical('subsample', [0.5, 0.6, 0.7, 0.8,
        'learning_rate': trial.suggest_float('learning_rate', 0.005, 0.05, log=1
        'n_estimators': trial.suggest_int('n_estimators', 200, 1000, step=100),
        'max_depth': trial.suggest_int('max_depth', 3, 12),
        'min_child_weight': trial.suggest_int('min_child_weight', 1, 300),
        'random_state': 42
    }

    model = XGBRegressor(**param, verbosity=0)
    model.fit(X_train_scaled, y_train)
    y_pred = model.predict(X_test_scaled)
    mse = mean_squared_error(y_test, y_pred)
    return mse

# --- Hyperparameter tuning for LGBMRegressor ---
def objective_lgbm(trial):
    param = {
```

```

        'device': 'gpu',                    # GPU acceleration
        'gpu_platform_id': 0,
        'gpu_device_id': 0,
        'boosting_type': 'gbdt',
        'objective': 'regression',
        'metric': 'mse',

        # Regularization (not too extreme)
        'lambda_l1': trial.suggest_float('lambda_l1', 1e-5, 1.0, log=True),
        'lambda_l2': trial.suggest_float('lambda_l2', 1e-5, 1.0, log=True),

        # Tree and data sampling
        'num_leaves': trial.suggest_int('num_leaves', 16, 256),
        'feature_fraction': trial.suggest_float('feature_fraction', 0.5, 1.0),
        'bagging_fraction': trial.suggest_float('bagging_fraction', 0.5, 1.0),
        'bagging_freq': trial.suggest_int('bagging_freq', 1, 7),
        'min_child_samples': trial.suggest_int('min_child_samples', 10, 100),

        # Learning control
        'learning_rate': trial.suggest_float('learning_rate', 0.005, 0.3, log=True),
        'n_estimators': trial.suggest_int('n_estimators', 200, 1000, step=100),
        'max_depth': trial.suggest_int('max_depth', 3, 12),

        'random_state': 42,
        'verbosity': -1
    }

    model = LGBMRegressor(**param)
    model.fit(X_train_scaled, y_train)
    y_pred = model.predict(X_test_scaled)
    mse = mean_squared_error(y_test, y_pred)
    return mse

# --- Run GPU-accelerated Optuna optimization ---
print("\n🚀 Tuning XGBRegressor (GPU)...")
study_xgb = optuna.create_study(direction='minimize')
study_xgb.optimize(objective_xgb, n_trials=150, timeout=7200)
best_params_xgb = study_xgb.best_params
print(f"✅ Best XGBRegressor parameters: {best_params_xgb}")

print("\n🚀 Tuning LGBMRegressor (GPU)...")
study_lgbm = optuna.create_study(direction='minimize')
study_lgbm.optimize(objective_lgbm, n_trials=150, timeout=7200)
best_params_lgbm = study_lgbm.best_params
print(f"✅ Best LGBMRegressor parameters: {best_params_lgbm}")

# --- Initialize models with tuned GPU parameters ---
xgb_model = XGBRegressor(**best_params_xgb, tree_method='gpu_hist', predictor='gpu')
lgbm_model = LGBMRegressor(**best_params_lgbm, device='gpu')

models = [
    ("XGBRegressor (GPU)", xgb_model),
    ("LGBMRegressor (GPU)", lgbm_model)
]

print("\n📊 Evaluating Tuned Models on GPU...\n")
mse_scores = []
model_names = []

```

```
for name, model in models:
    model.fit(X_train_scaled, y_train)
    y_pred = model.predict(X_test_scaled)
    mse = mean_squared_error(y_test, y_pred)
    mae = mean_absolute_error(y_test, y_pred)
    r2 = r2_score(y_test, y_pred)

    mse_scores.append(mse)
    model_names.append(name)

    print(f"{name:<30} | MSE: {mse:.5f} | MAE: {mae:.5f} | R²: {r2:.5f}")
```

[I 2025-11-03 11:43:52,593] A new study created in memory with name: no-name-ff770641bc08-43b9-af19-798a2a82345a

 Tuning XGBRegressor (GPU)...

[I 2025-11-03 11:43:57,913] Trial 0 finished with value: 0.07632955516668916 and parameters: {'lambda': 0.8383583304877532, 'alpha': 1.173028799530471, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.010427893322198945, 'n\_estimators': 1000, 'max\_depth': 4, 'min\_child\_weight': 55}. Best is trial 0 with value: 0.07632955516668916

[I 2025-11-03 11:43:59,697] Trial 1 finished with value: 0.09102683518957719 and parameters: {'lambda': 2.1506909993734054, 'alpha': 0.1857388242142831, 'colsample\_bytree': 0.3, 'subsample': 0.6, 'learning\_rate': 0.010024876282526348, 'n\_estimators': 300, 'max\_depth': 4, 'min\_child\_weight': 291}. Best is trial 0 with value: 0.07632955516668916

[I 2025-11-03 11:44:06,277] Trial 2 finished with value: 0.07552426250713631 and parameters: {'lambda': 5.056860129363169, 'alpha': 0.36413765829911, 'colsample\_bytree': 0.7, 'subsample': 0.7, 'learning\_rate': 0.01237581281038807, 'n\_estimators': 900, 'max\_depth': 7, 'min\_child\_weight': 141}. Best is trial 2 with value: 0.07552426250713631

[I 2025-11-03 11:44:12,539] Trial 3 finished with value: 0.07568618943159515 and parameters: {'lambda': 0.0018824683509739745, 'alpha': 7.523465924930618, 'colsample\_bytree': 0.9, 'subsample': 0.5, 'learning\_rate': 0.010021366076504128, 'n\_estimators': 1000, 'max\_depth': 6, 'min\_child\_weight': 184}. Best is trial 2 with value: 0.07552426250713631

[I 2025-11-03 11:44:22,949] Trial 4 finished with value: 0.07558606617539025 and parameters: {'lambda': 3.4945070197845784, 'alpha': 0.003129437977161099, 'colsample\_bytree': 1.0, 'subsample': 0.8, 'learning\_rate': 0.012808986326623684, 'n\_estimators': 700, 'max\_depth': 10, 'min\_child\_weight': 27}. Best is trial 2 with value: 0.07552426250713631

[I 2025-11-03 11:44:24,874] Trial 5 finished with value: 0.07714226022876179 and parameters: {'lambda': 0.0033751744590372456, 'alpha': 0.002008846237620443, 'colsample\_bytree': 1.0, 'subsample': 1.0, 'learning\_rate': 0.01059785026061806, 'n\_estimators': 300, 'max\_depth': 5, 'min\_child\_weight': 2}. Best is trial 2 with value: 0.07552426250713631

[I 2025-11-03 11:44:34,715] Trial 6 finished with value: 0.07582580454989478 and parameters: {'lambda': 3.4602577325232358, 'alpha': 0.0060891746953967586, 'colsample\_bytree': 0.5, 'subsample': 0.7, 'learning\_rate': 0.035570902072720116, 'n\_estimators': 1000, 'max\_depth': 9, 'min\_child\_weight': 62}. Best is trial 2 with value: 0.07552426250713631

[I 2025-11-03 11:44:41,290] Trial 7 finished with value: 0.07557704701828077 and parameters: {'lambda': 5.450726862653405, 'alpha': 0.021457398999961276, 'colsample\_bytree': 1.0, 'subsample': 0.6, 'learning\_rate': 0.008665311706522214, 'n\_estimators': 900, 'max\_depth': 7, 'min\_child\_weight': 228}. Best is trial 2 with value: 0.07552426250713631

[I 2025-11-03 11:44:43,570] Trial 8 finished with value: 0.07685455875578083 and parameters: {'lambda': 0.6310450304195235, 'alpha': 0.005853983141710789, 'colsample\_bytree': 0.5, 'subsample': 0.6, 'learning\_rate': 0.021497809644365613, 'n\_estimators': 200, 'max\_depth': 8, 'min\_child\_weight': 146}. Best is trial 2 with value: 0.07552426250713631

[I 2025-11-03 11:44:44,749] Trial 9 finished with value: 0.07765073566746107 and parameters: {'lambda': 0.2518128873229522, 'alpha': 0.3009810814869619, 'colsample\_bytree': 0.7, 'subsample': 0.6, 'learning\_rate': 0.0405524506681664, 'n\_estimators': 200, 'max\_depth': 3, 'min\_child\_weight': 35}. Best is trial 2 with value: 0.07552426250713631

[I 2025-11-03 11:44:59,586] Trial 10 finished with value: 0.07608671115705751 and parameters: {'lambda': 0.015878510478442284, 'alpha': 1.478524656242347, 'colsample\_bytree': 0.7, 'subsample': 0.7, 'learning\_rate': 0.00578226791101601, 'n\_estimators': 700, 'max\_depth': 12, 'min\_child\_weight': 120}. Best is trial 2 with value: 0.07552426250713631

[I 2025-11-03 11:45:05,606] Trial 11 finished with value: 0.07610932515033904 and parameters: {'lambda': 8.857118401949371, 'alpha': 0.032893550605661126, 'colsample\_bytree': 0.7, 'subsample': 0.7, 'learning\_rate': 0.005867249706817346, 'n\_estimators': 800, 'max\_depth': 7, 'min\_child\_weight': 228}. Best is trial 2 with value: 0.07552426250713631

[I 2025-11-03 11:45:11,159] Trial 12 finished with value: 0.07549012048036333 and parameters: {'lambda': 0.0885451154205654, 'alpha': 0.038059154295329606, 'colsample\_bytree': 1.0, 'subsample': 1.0, 'learning\_rate': 0.0183113122960142, 'n\_estimators': 800, 'max\_depth': 7, 'min\_child\_weight': 225}. Best is trial 12 with value: 0.07549012048036333

0.07549012048036333.  
[I 2025-11-03 11:45:18,059] Trial 13 finished with value: 0.07681066109519062 and parameters: {'lambda': 0.06473876151634027, 'alpha': 0.07102577349228667, 'colsample\_bytree': 0.3, 'subsample': 1.0, 'learning\_rate': 0.01989639234318233, 'n\_estimators': 500, 'max\_depth': 10, 'min\_child\_weight': 202}. Best is trial 12 with value: 0.07549012048036333.  
[I 2025-11-03 11:45:21,777] Trial 14 finished with value: 0.07570219334843499 and parameters: {'lambda': 0.06207358154355, 'alpha': 0.6051464155076355, 'colsample\_bytree': 0.7, 'subsample': 1.0, 'learning\_rate': 0.026429262636811102, 'n\_estimators': 600, 'max\_depth': 6, 'min\_child\_weight': 106}. Best is trial 12 with value: 0.07549012048036333.  
[I 2025-11-03 11:45:28,245] Trial 15 finished with value: 0.07549031467730678 and parameters: {'lambda': 0.012120494003708359, 'alpha': 0.07591630318200299, 'colsample\_bytree': 1.0, 'subsample': 0.5, 'learning\_rate': 0.01619971362749535, 'n\_estimators': 800, 'max\_depth': 8, 'min\_child\_weight': 289}. Best is trial 12 with value: 0.07549012048036333.  
[I 2025-11-03 11:45:33,462] Trial 16 finished with value: 0.07552943325667832 and parameters: {'lambda': 0.010332696651996542, 'alpha': 0.017711483931536074, 'colsample\_bytree': 1.0, 'subsample': 0.5, 'learning\_rate': 0.0167766762195429, 'n\_estimators': 500, 'max\_depth': 9, 'min\_child\_weight': 278}. Best is trial 12 with value: 0.07549012048036333.  
[I 2025-11-03 11:45:44,482] Trial 17 finished with value: 0.07586900262363777 and parameters: {'lambda': 0.015398960881160245, 'alpha': 0.07855479675543538, 'colsample\_bytree': 1.0, 'subsample': 0.5, 'learning\_rate': 0.029430021585710384, 'n\_estimators': 800, 'max\_depth': 12, 'min\_child\_weight': 253}. Best is trial 12 with value: 0.07549012048036333.  
[I 2025-11-03 11:45:50,431] Trial 18 finished with value: 0.07549147296837934 and parameters: {'lambda': 0.1687370072622863, 'alpha': 0.045020464732620176, 'colsample\_bytree': 1.0, 'subsample': 0.5, 'learning\_rate': 0.01583977510321185, 'n\_estimators': 700, 'max\_depth': 8, 'min\_child\_weight': 253}. Best is trial 12 with value: 0.07549012048036333.  
[I 2025-11-03 11:45:59,497] Trial 19 finished with value: 0.07566901343023981 and parameters: {'lambda': 0.03225704002106962, 'alpha': 0.012537785306464681, 'colsample\_bytree': 1.0, 'subsample': 1.0, 'learning\_rate': 0.022199689601051408, 'n\_estimators': 800, 'max\_depth': 10, 'min\_child\_weight': 188}. Best is trial 12 with value: 0.07549012048036333.  
[I 2025-11-03 11:46:03,180] Trial 20 finished with value: 0.07557681964364607 and parameters: {'lambda': 0.007559863995497239, 'alpha': 0.0011519722476453229, 'colsample\_bytree': 1.0, 'subsample': 1.0, 'learning\_rate': 0.02738393192709287, 'n\_estimators': 600, 'max\_depth': 6, 'min\_child\_weight': 299}. Best is trial 12 with value: 0.07549012048036333.  
[I 2025-11-03 11:46:09,033] Trial 21 finished with value: 0.07549645126290991 and parameters: {'lambda': 0.1772145349943117, 'alpha': 0.04287968659020219, 'colsample\_bytree': 1.0, 'subsample': 0.5, 'learning\_rate': 0.016552472880414944, 'n\_estimators': 700, 'max\_depth': 8, 'min\_child\_weight': 263}. Best is trial 12 with value: 0.07549012048036333.  
[I 2025-11-03 11:46:17,664] Trial 22 finished with value: 0.075484359695952 and parameters: {'lambda': 0.23986036783323028, 'alpha': 0.12352415042575211, 'colsample\_bytree': 1.0, 'subsample': 0.5, 'learning\_rate': 0.014220462408932022, 'n\_estimators': 900, 'max\_depth': 9, 'min\_child\_weight': 236}. Best is trial 22 with value: 0.075484359695952.  
[I 2025-11-03 11:46:26,873] Trial 23 finished with value: 0.07553298944541946 and parameters: {'lambda': 0.4862771757632209, 'alpha': 0.17919429022178196, 'colsample\_bytree': 1.0, 'subsample': 0.5, 'learning\_rate': 0.007528684942489108, 'n\_estimators': 900, 'max\_depth': 9, 'min\_child\_weight': 241}. Best is trial 22 with value: 0.075484359695952.  
[I 2025-11-03 11:46:35,625] Trial 24 finished with value: 0.07548454210772945 and parameters: {'lambda': 0.03802126972245361, 'alpha': 0.1354925421208856, 'colsample\_bytree': 1.0, 'subsample': 0.5, 'learning\_rate': 0.013310341763111768, 'n\_estimators': 900, 'max\_depth': 9, 'min\_child\_weight': 213}. Best is trial 22 with value: 0.075484359695952.  
[I 2025-11-03 11:46:48,144] Trial 25 finished with value: 0.07670658923917587 and

parameters: {'lambda': 0.047512805730177014, 'alpha': 0.1738995822727996, 'colsample\_bytree': 0.3, 'subsample': 0.5, 'learning\_rate': 0.013018383304654334, 'n\_estimators': 900, 'max\_depth': 11, 'min\_child\_weight': 212}. Best is trial 22 with value: 0.075484359695952.

[I 2025-11-03 11:47:00,623] Trial 26 finished with value: 0.07556305242551296 and parameters: {'lambda': 0.11176225851759904, 'alpha': 2.3162219451133077, 'colsample\_bytree': 0.5, 'subsample': 0.8, 'learning\_rate': 0.019040856803420294, 'n\_estimators': 900, 'max\_depth': 11, 'min\_child\_weight': 180}. Best is trial 22 with value: 0.075484359695952.

[I 2025-11-03 11:47:10,555] Trial 27 finished with value: 0.07552458249979013 and parameters: {'lambda': 0.029760661905466113, 'alpha': 0.6737481099265328, 'colsample\_bytree': 0.9, 'subsample': 1.0, 'learning\_rate': 0.01261743092633045, 'n\_estimators': 1000, 'max\_depth': 9, 'min\_child\_weight': 172}. Best is trial 22 with value: 0.075484359695952.

[I 2025-11-03 11:47:22,455] Trial 28 finished with value: 0.07555620745044744 and parameters: {'lambda': 0.3781337620777367, 'alpha': 0.010975912785975988, 'colsample\_bytree': 1.0, 'subsample': 0.5, 'learning\_rate': 0.007785044063481766, 'n\_estimators': 800, 'max\_depth': 11, 'min\_child\_weight': 214}. Best is trial 22 with value: 0.075484359695952.

[I 2025-11-03 11:47:27,678] Trial 29 finished with value: 0.07574881595490467 and parameters: {'lambda': 0.8671829420566466, 'alpha': 0.1380424773587878, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.014425369523178558, 'n\_estimators': 1000, 'max\_depth': 5, 'min\_child\_weight': 157}. Best is trial 22 with value: 0.075484359695952.

[I 2025-11-03 11:47:33,390] Trial 30 finished with value: 0.07556043465409891 and parameters: {'lambda': 0.10240195050860616, 'alpha': 0.41498397864654285, 'colsample\_bytree': 1.0, 'subsample': 0.5, 'learning\_rate': 0.025431681516244108, 'n\_estimators': 500, 'max\_depth': 10, 'min\_child\_weight': 267}. Best is trial 22 with value: 0.075484359695952.

[I 2025-11-03 11:47:39,865] Trial 31 finished with value: 0.07547614531428071 and parameters: {'lambda': 0.006185723461320242, 'alpha': 0.06588522401150843, 'colsample\_bytree': 1.0, 'subsample': 0.5, 'learning\_rate': 0.018420012481838346, 'n\_estimators': 800, 'max\_depth': 8, 'min\_child\_weight': 240}. Best is trial 31 with value: 0.07547614531428071.

[I 2025-11-03 11:47:46,000] Trial 32 finished with value: 0.07547714465768965 and parameters: {'lambda': 0.004346588766095832, 'alpha': 0.10519496115338721, 'colsample\_bytree': 1.0, 'subsample': 0.5, 'learning\_rate': 0.018836182060810436, 'n\_estimators': 900, 'max\_depth': 7, 'min\_child\_weight': 227}. Best is trial 31 with value: 0.07547614531428071.

[I 2025-11-03 11:47:53,796] Trial 33 finished with value: 0.07702486365536863 and parameters: {'lambda': 0.0035970364706059393, 'alpha': 0.1108439830769643, 'colsample\_bytree': 0.3, 'subsample': 0.5, 'learning\_rate': 0.01099150127652529, 'n\_estimators': 900, 'max\_depth': 8, 'min\_child\_weight': 240}. Best is trial 31 with value: 0.07547614531428071.

[I 2025-11-03 11:48:03,336] Trial 34 finished with value: 0.07549993866707493 and parameters: {'lambda': 0.0010799473438800771, 'alpha': 0.24951572693323526, 'colsample\_bytree': 1.0, 'subsample': 0.5, 'learning\_rate': 0.014603375011459278, 'n\_estimators': 1000, 'max\_depth': 9, 'min\_child\_weight': 203}. Best is trial 31 with value: 0.07547614531428071.

[I 2025-11-03 11:48:09,517] Trial 35 finished with value: 0.07547601581912161 and parameters: {'lambda': 0.005568327207131385, 'alpha': 0.10706956955533711, 'colsample\_bytree': 1.0, 'subsample': 0.5, 'learning\_rate': 0.022899803725614676, 'n\_estimators': 900, 'max\_depth': 7, 'min\_child\_weight': 194}. Best is trial 35 with value: 0.07547601581912161.

[I 2025-11-03 11:48:14,670] Trial 36 finished with value: 0.0756382940639091 and parameters: {'lambda': 0.004823415088346372, 'alpha': 0.05764745340452676, 'colsample\_bytree': 0.9, 'subsample': 0.5, 'learning\_rate': 0.03181381910329908, 'n\_estimators': 1000, 'max\_depth': 5, 'min\_child\_weight': 192}. Best is trial 35 with value: 0.07547601581912161.

[I 2025-11-03 11:48:20,234] Trial 37 finished with value: 0.07547024116763695 and parameters: {'lambda': 0.002330647382254613, 'alpha': 9.881484346881862,



'colsample\_bytree': 1.0, 'subsample': 0.5, 'learning\_rate': 0.02513589653066647, 'n\_estimators': 900, 'max\_depth': 6, 'min\_child\_weight': 163}. Best is trial 37 with 0.07547024116763695.

[I 2025-11-03 11:48:25,172] Trial 38 finished with value: 0.07578984992778731 and parameters: {'lambda': 0.001994315328942234, 'alpha': 2.4895714718876, 'colsample\_bytree': 0.5, 'subsample': 0.5, 'learning\_rate': 0.02150191721587161, 'n\_estimators': 800, 'max\_depth': 6, 'min\_child\_weight': 163}. Best is trial 37 with value: 0.07547024116763695.

[I 2025-11-03 11:48:29,385] Trial 39 finished with value: 0.07592234989470775 and parameters: {'lambda': 0.0018245435931542684, 'alpha': 4.570399518748881, 'colsample\_bytree': 1.0, 'subsample': 0.8, 'learning\_rate': 0.02385266434025136, 'n\_estimators': 900, 'max\_depth': 4, 'min\_child\_weight': 132}. Best is trial 37 with 0.07547024116763695.

[I 2025-11-03 11:48:34,634] Trial 40 finished with value: 0.07551207809793065 and parameters: {'lambda': 0.005319784308303863, 'alpha': 8.20542550032551, 'colsample\_bytree': 1.0, 'subsample': 0.6, 'learning\_rate': 0.049029578967448736, 'n\_estimators': 700, 'max\_depth': 7, 'min\_child\_weight': 99}. Best is trial 37 with value: 0.07547024116763695.

[I 2025-11-03 11:48:41,433] Trial 41 finished with value: 0.07547845845196222 and parameters: {'lambda': 0.0010356182122314701, 'alpha': 0.025399340918710794, 'colsample\_bytree': 1.0, 'subsample': 0.5, 'learning\_rate': 0.01881514145992451, 'n\_estimators': 1000, 'max\_depth': 7, 'min\_child\_weight': 230}. Best is trial 37 with value: 0.07547024116763695.

[I 2025-11-03 11:48:48,163] Trial 42 finished with value: 0.0755504912601819 and parameters: {'lambda': 0.0010931006694687379, 'alpha': 0.025205386765315047, 'colsample\_bytree': 1.0, 'subsample': 0.5, 'learning\_rate': 0.034249674272826186, 'n\_estimators': 1000, 'max\_depth': 7, 'min\_child\_weight': 198}. Best is trial 37 with value: 0.07547024116763695.

[I 2025-11-03 11:48:53,262] Trial 43 finished with value: 0.0756089402311531 and parameters: {'lambda': 0.0022392307656793346, 'alpha': 0.005806720325908507, 'colsample\_bytree': 1.0, 'subsample': 0.5, 'learning\_rate': 0.023841322488060982, 'n\_estimators': 1000, 'max\_depth': 5, 'min\_child\_weight': 172}. Best is trial 37 with value: 0.07547024116763695.

[I 2025-11-03 11:48:58,610] Trial 44 finished with value: 0.07549879161080637 and parameters: {'lambda': 0.003069578720511349, 'alpha': 0.0033960231155455638, 'colsample\_bytree': 1.0, 'subsample': 0.7, 'learning\_rate': 0.01844841852718345, 'n\_estimators': 900, 'max\_depth': 6, 'min\_child\_weight': 221}. Best is trial 37 with 0.07547024116763695.

[I 2025-11-03 11:49:05,568] Trial 45 finished with value: 0.07636067728321284 and parameters: {'lambda': 0.006516513094097119, 'alpha': 0.013752801134336155, 'colsample\_bytree': 0.3, 'subsample': 0.5, 'learning\_rate': 0.021347751757015056, 'n\_estimators': 1000, 'max\_depth': 7, 'min\_child\_weight': 141}. Best is trial 37 with value: 0.07547024116763695.

[I 2025-11-03 11:49:10,414] Trial 46 finished with value: 0.07575015336265722 and parameters: {'lambda': 0.001389406694685779, 'alpha': 0.9518899006618987, 'colsample\_bytree': 0.5, 'subsample': 0.5, 'learning\_rate': 0.02922788751574741, 'n\_estimators': 800, 'max\_depth': 6, 'min\_child\_weight': 254}. Best is trial 37 with 0.07547024116763695.

[I 2025-11-03 11:49:16,563] Trial 47 finished with value: 0.07556883121423835 and parameters: {'lambda': 0.003105215657812465, 'alpha': 0.008407653418655297, 'colsample\_bytree': 0.7, 'subsample': 0.6, 'learning\_rate': 0.03803544213536729, 'n\_estimators': 900, 'max\_depth': 7, 'min\_child\_weight': 180}. Best is trial 37 with 0.07547024116763695.

[I 2025-11-03 11:49:21,123] Trial 48 finished with value: 0.07594691296390581 and parameters: {'lambda': 0.020224393928662928, 'alpha': 0.2532865286961015, 'colsample\_bytree': 1.0, 'subsample': 0.7, 'learning\_rate': 0.020213769285456082, 'n\_estimators': 1000, 'max\_depth': 4, 'min\_child\_weight': 273}. Best is trial 37 with value: 0.07547024116763695.

[I 2025-11-03 11:49:28,674] Trial 49 finished with value: 0.0754783287773618 and parameters: {'lambda': 0.008093312128342198, 'alpha': 0.03164775586106354, 'colsample\_bytree': 1.0, 'subsample': 0.5, 'learning\_rate': 0.01767526702833187, 'n\_estimators': 900, 'max\_depth': 8, 'min\_child\_weight': 75}. Best is trial 37 with value: 0.07547024116763695.

0.07547024116763695.

[I 2025-11-03 11:49:32,457] Trial 50 finished with value: 0.075439189921324 and parameters: {'lambda': 0.010863881539104791, 'alpha': 0.5060571608350605, 'colsample\_bytree': 0.9, 'subsample': 0.5, 'learning\_rate': 0.024245035810304932, 'n\_estimators': 400, 'max\_depth': 8, 'min\_child\_weight': 46}. Best is trial 50 with value: 0.075439189921324.

[I 2025-11-03 11:49:35,454] Trial 51 finished with value: 0.07549676459432225 and parameters: {'lambda': 0.009329987590655276, 'alpha': 0.36127231258637493, 'colsample\_bytree': 0.9, 'subsample': 0.5, 'learning\_rate': 0.023777359548151283, 'n\_estimators': 300, 'max\_depth': 8, 'min\_child\_weight': 61}. Best is trial 50 with value: 0.075439189921324.

[I 2025-11-03 11:49:38,527] Trial 52 finished with value: 0.07561383811047807 and parameters: {'lambda': 0.004493512942089764, 'alpha': 4.806532623338266, 'colsample\_bytree': 0.9, 'subsample': 0.5, 'learning\_rate': 0.018009606681864593, 'n\_estimators': 300, 'max\_depth': 8, 'min\_child\_weight': 31}. Best is trial 50 with value: 0.075439189921324.

[I 2025-11-03 11:49:40,749] Trial 53 finished with value: 0.07555947974089855 and parameters: {'lambda': 0.02184073658668367, 'alpha': 0.054917092922871974, 'colsample\_bytree': 0.9, 'subsample': 0.5, 'learning\_rate': 0.026832649266462387, 'n\_estimators': 200, 'max\_depth': 8, 'min\_child\_weight': 50}. Best is trial 50 with value: 0.075439189921324.

[I 2025-11-03 11:49:43,977] Trial 54 finished with value: 0.07557641368130288 and parameters: {'lambda': 0.0070824459881865, 'alpha': 0.0832842172397579, 'colsample\_bytree': 0.9, 'subsample': 0.5, 'learning\_rate': 0.017318031858112537, 'n\_estimators': 400, 'max\_depth': 7, 'min\_child\_weight': 5}. Best is trial 50 with value: 0.075439189921324.

[I 2025-11-03 11:49:47,624] Trial 55 finished with value: 0.07546171158735464 and parameters: {'lambda': 0.014587844409784086, 'alpha': 0.030703468135406493, 'colsample\_bytree': 1.0, 'subsample': 0.5, 'learning\_rate': 0.029604908067549323, 'n\_estimators': 400, 'max\_depth': 8, 'min\_child\_weight': 71}. Best is trial 50 with value: 0.075439189921324.

[I 2025-11-03 11:49:50,303] Trial 56 finished with value: 0.07554876720059245 and parameters: {'lambda': 0.012290139554202594, 'alpha': 0.5059077810023211, 'colsample\_bytree': 1.0, 'subsample': 0.6, 'learning\_rate': 0.031004221668745616, 'n\_estimators': 400, 'max\_depth': 6, 'min\_child\_weight': 91}. Best is trial 50 with value: 0.075439189921324.

[I 2025-11-03 11:49:54,249] Trial 57 finished with value: 0.0755413877029696 and parameters: {'lambda': 0.002567210462643055, 'alpha': 0.9346005039990347, 'colsample\_bytree': 0.7, 'subsample': 0.5, 'learning\_rate': 0.022925147359101426, 'n\_estimators': 400, 'max\_depth': 8, 'min\_child\_weight': 11}. Best is trial 50 with value: 0.075439189921324.

[I 2025-11-03 11:49:57,081] Trial 58 finished with value: 0.07569843679163102 and parameters: {'lambda': 0.014852246635988699, 'alpha': 1.67989482134639, 'colsample\_bytree': 1.0, 'subsample': 0.7, 'learning\_rate': 0.02835703601638756, 'n\_estimators': 500, 'max\_depth': 5, 'min\_child\_weight': 45}. Best is trial 50 with value: 0.075439189921324.

[I 2025-11-03 11:49:59,764] Trial 59 finished with value: 0.0756328709242339 and parameters: {'lambda': 0.0052304552354490745, 'alpha': 0.06437551030945574, 'colsample\_bytree': 1.0, 'subsample': 0.8, 'learning\_rate': 0.02544955506213436, 'n\_estimators': 400, 'max\_depth': 6, 'min\_child\_weight': 129}. Best is trial 50 with value: 0.075439189921324.

[I 2025-11-03 11:50:04,133] Trial 60 finished with value: 0.07639840311324031 and parameters: {'lambda': 0.0038737890432101138, 'alpha': 0.018931794074783535, 'colsample\_bytree': 0.3, 'subsample': 0.5, 'learning\_rate': 0.03278891862439032, 'n\_estimators': 600, 'max\_depth': 7, 'min\_child\_weight': 74}. Best is trial 50 with value: 0.075439189921324.

[I 2025-11-03 11:50:10,841] Trial 61 finished with value: 0.07547927005235422 and parameters: {'lambda': 0.008779424654552113, 'alpha': 0.03774410604212471, 'colsample\_bytree': 1.0, 'subsample': 0.5, 'learning\_rate': 0.02025095779054832, 'n\_estimators': 800, 'max\_depth': 8, 'min\_child\_weight': 73}. Best is trial 50 with value: 0.075439189921324.

[I 2025-11-03 11:50:18,625] Trial 62 finished with value: 0.07549514198721098 and parameters: {'lambda': 0.020177173557854387, 'alpha': 0.027666697937656394,



'colsample\_bytree': 1.0, 'subsample': 0.5, 'learning\_rate': 0.015663666167359536, 'n\_estimators': 900, 'max\_depth': 8, 'min\_child\_weight': 23}. Best is trial 50 with value: 0.075439189921324.

[I 2025-11-03 11:50:23,751] Trial 63 finished with value: 0.07574661384579232 and parameters: {'lambda': 0.011045694563066673, 'alpha': 0.09357148542166163, 'colsample\_bytree': 1.0, 'subsample': 0.5, 'learning\_rate': 0.04157271120116692, 'n\_estimators': 500, 'max\_depth': 9, 'min\_child\_weight': 86}. Best is trial 50 with value: 0.075439189921324.

[I 2025-11-03 11:50:30,530] Trial 64 finished with value: 0.0757225303972139 and parameters: {'lambda': 0.007957906401569551, 'alpha': 0.04660906713552691, 'colsample\_bytree': 1.0, 'subsample': 0.5, 'learning\_rate': 0.0051786128407352566, 'n\_estimators': 900, 'max\_depth': 7, 'min\_child\_weight': 41}. Best is trial 50 with value: 0.075439189921324.

[I 2025-11-03 11:50:37,466] Trial 65 finished with value: 0.0755791157521627 and parameters: {'lambda': 0.0015645477223802256, 'alpha': 0.03422381059203743, 'colsample\_bytree': 1.0, 'subsample': 0.5, 'learning\_rate': 0.025054686499493772, 'n\_estimators': 700, 'max\_depth': 9, 'min\_child\_weight': 118}. Best is trial 50 with value: 0.075439189921324.

[I 2025-11-03 11:50:44,606] Trial 66 finished with value: 0.07565296217095617 and parameters: {'lambda': 0.006360222216572411, 'alpha': 0.17900542740894665, 'colsample\_bytree': 0.5, 'subsample': 0.5, 'learning\_rate': 0.011354975619667458, 'n\_estimators': 800, 'max\_depth': 8, 'min\_child\_weight': 72}. Best is trial 50 with value: 0.075439189921324.

[I 2025-11-03 11:50:47,747] Trial 67 finished with value: 0.07558754010455906 and parameters: {'lambda': 0.0027396547444191, 'alpha': 5.451547062091901, 'colsample\_bytree': 0.9, 'subsample': 1.0, 'learning\_rate': 0.020408196286194776, 'n\_estimators': 400, 'max\_depth': 7, 'min\_child\_weight': 60}. Best is trial 50 with value: 0.075439189921324.

[I 2025-11-03 11:50:49,344] Trial 68 finished with value: 0.07653765862739546 and parameters: {'lambda': 0.02503556716630266, 'alpha': 0.0152330213882813, 'colsample\_bytree': 1.0, 'subsample': 0.5, 'learning\_rate': 0.015324384401571694, 'n\_estimators': 200, 'max\_depth': 6, 'min\_child\_weight': 111}. Best is trial 50 with value: 0.075439189921324.

[I 2025-11-03 11:50:52,466] Trial 69 finished with value: 0.07585533657132842 and parameters: {'lambda': 0.014553925438885793, 'alpha': 0.10295735244913372, 'colsample\_bytree': 0.7, 'subsample': 0.5, 'learning\_rate': 0.016918591362448453, 'n\_estimators': 300, 'max\_depth': 8, 'min\_child\_weight': 148}. Best is trial 50 with value: 0.075439189921324.

[I 2025-11-03 11:51:02,124] Trial 70 finished with value: 0.07572550570827236 and parameters: {'lambda': 1.432526219374105, 'alpha': 0.2504331479491493, 'colsample\_bytree': 1.0, 'subsample': 0.5, 'learning\_rate': 0.022788730100505316, 'n\_estimators': 900, 'max\_depth': 9, 'min\_child\_weight': 21}. Best is trial 50 with value: 0.075439189921324.

[I 2025-11-03 11:51:08,382] Trial 71 finished with value: 0.07547569126462185 and parameters: {'lambda': 0.003695897166679978, 'alpha': 0.028482934496597133, 'colsample\_bytree': 1.0, 'subsample': 0.5, 'learning\_rate': 0.018351297349585023, 'n\_estimators': 900, 'max\_depth': 7, 'min\_child\_weight': 233}. Best is trial 50 with value: 0.075439189921324.

[I 2025-11-03 11:51:14,593] Trial 72 finished with value: 0.07549498762046877 and parameters: {'lambda': 0.004197337878315534, 'alpha': 0.010462068895201456, 'colsample\_bytree': 1.0, 'subsample': 0.5, 'learning\_rate': 0.01909978652112282, 'n\_estimators': 900, 'max\_depth': 7, 'min\_child\_weight': 247}. Best is trial 50 with value: 0.075439189921324.

[I 2025-11-03 11:51:21,088] Trial 73 finished with value: 0.07549312525332391 and parameters: {'lambda': 0.005850702373303156, 'alpha': 0.01989857862546407, 'colsample\_bytree': 1.0, 'subsample': 0.5, 'learning\_rate': 0.021716586623267264, 'n\_estimators': 800, 'max\_depth': 8, 'min\_child\_weight': 221}. Best is trial 50 with value: 0.075439189921324.

[I 2025-11-03 11:51:27,331] Trial 74 finished with value: 0.07547540066892883 and parameters: {'lambda': 0.0021953406679068644, 'alpha': 0.054513445480273606, 'colsample\_bytree': 1.0, 'subsample': 0.5, 'learning\_rate': 0.017399208755150334, 'n\_estimators': 900, 'max\_depth': 7, 'min\_child\_weight': 201}. Best is trial 50 with value: 0.075439189921324.

0.075439189921324.  
[I 2025-11-03 11:51:32,113] Trial 75 finished with value: 0.07546719918517628 and parameters: {'lambda': 0.0014963376847062814, 'alpha': 0.0533713072529749, 'colsample\_bytree': 1.0, 'subsample': 0.8, 'learning\_rate': 0.026700646781472503, 'n\_estimators': 800, 'max\_depth': 6, 'min\_child\_weight': 207}. Best is trial 50 with 0.075439189921324.  
[I 2025-11-03 11:51:35,841] Trial 76 finished with value: 0.07550331749088598 and parameters: {'lambda': 0.0015984838191856498, 'alpha': 0.04424597664435875, 'colsample\_bytree': 1.0, 'subsample': 0.8, 'learning\_rate': 0.030375330129273445, 'n\_estimators': 600, 'max\_depth': 6, 'min\_child\_weight': 210}. Best is trial 50 with 0.075439189921324.  
[I 2025-11-03 11:51:40,669] Trial 77 finished with value: 0.07546052610613628 and parameters: {'lambda': 0.0013365204249627689, 'alpha': 0.06590799849521402, 'colsample\_bytree': 1.0, 'subsample': 0.8, 'learning\_rate': 0.02755518526258679, 'n\_estimators': 800, 'max\_depth': 6, 'min\_child\_weight': 199}. Best is trial 50 with 0.075439189921324.  
[I 2025-11-03 11:51:44,386] Trial 78 finished with value: 0.07562240840738914 and parameters: {'lambda': 0.0012860173859901337, 'alpha': 0.05355577512671169, 'colsample\_bytree': 1.0, 'subsample': 0.8, 'learning\_rate': 0.027114770636234867, 'n\_estimators': 700, 'max\_depth': 5, 'min\_child\_weight': 194}. Best is trial 50 with 0.075439189921324.  
[I 2025-11-03 11:51:49,239] Trial 79 finished with value: 0.0754427613958952 and parameters: {'lambda': 0.002067382411646995, 'alpha': 3.3828416002775024, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.03635634542005561, 'n\_estimators': 800, 'max\_depth': 6, 'min\_child\_weight': 204}. Best is trial 50 with 0.075439189921324.  
[I 2025-11-03 11:51:52,209] Trial 80 finished with value: 0.07661640177570649 and parameters: {'lambda': 0.002000211182877154, 'alpha': 3.1087021844740175, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.047614025415905634, 'n\_estimators': 700, 'max\_depth': 3, 'min\_child\_weight': 168}. Best is trial 50 with 0.075439189921324.  
[I 2025-11-03 11:51:57,145] Trial 81 finished with value: 0.07547426679200946 and parameters: {'lambda': 0.002449012217244119, 'alpha': 8.94759764236567, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.03526736186700585, 'n\_estimators': 800, 'max\_depth': 6, 'min\_child\_weight': 204}. Best is trial 50 with value: 0.075439189921324.  
[I 2025-11-03 11:52:02,083] Trial 82 finished with value: 0.07546200022989914 and parameters: {'lambda': 0.002314513321465262, 'alpha': 5.793106896837789, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.036625649019080594, 'n\_estimators': 800, 'max\_depth': 6, 'min\_child\_weight': 205}. Best is trial 50 with 0.075439189921324.  
[I 2025-11-03 11:52:06,969] Trial 83 finished with value: 0.07544480487006397 and parameters: {'lambda': 0.002389250417796057, 'alpha': 6.039421425106054, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.036368634232656974, 'n\_estimators': 800, 'max\_depth': 6, 'min\_child\_weight': 183}. Best is trial 50 with 0.075439189921324.  
[I 2025-11-03 11:52:11,872] Trial 84 finished with value: 0.07545562492787092 and parameters: {'lambda': 0.0013688370566096227, 'alpha': 7.083503829903572, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.03615293420671222, 'n\_estimators': 800, 'max\_depth': 6, 'min\_child\_weight': 185}. Best is trial 50 with 0.075439189921324.  
[I 2025-11-03 11:52:16,135] Trial 85 finished with value: 0.07554564065598839 and parameters: {'lambda': 0.0013593958166198963, 'alpha': 6.346461568961656, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.040706799151672725, 'n\_estimators': 800, 'max\_depth': 5, 'min\_child\_weight': 185}. Best is trial 50 with 0.075439189921324.  
[I 2025-11-03 11:52:19,906] Trial 86 finished with value: 0.07560314251391576 and parameters: {'lambda': 0.0016251318665594545, 'alpha': 3.592914673865665, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.03774014934698808, 'n\_estimators': 700, 'max\_depth': 5, 'min\_child\_weight': 177}. Best is trial 50 with 0.075439189921324.

[I 2025-11-03 11:52:24,801] Trial 87 finished with value: 0.07545540944124143 and parameters: {'lambda': 0.0012371898635461435, 'alpha': 7.180705753837229, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.043797548428441184, 'n\_estimators': 800, 'max\_depth': 6, 'min\_child\_weight': 157}. Best is trial 50 with 0.075439189921324.

[I 2025-11-03 11:52:29,702] Trial 88 finished with value: 0.07543383386945227 and parameters: {'lambda': 0.0012220885869419348, 'alpha': 6.581082170203246, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.044075278008277416, 'n\_estimators': 800, 'max\_depth': 6, 'min\_child\_weight': 158}. Best is trial 88 with 0.07543383386945227.

[I 2025-11-03 11:52:34,609] Trial 89 finished with value: 0.07543665046224157 and parameters: {'lambda': 0.0011530651784907192, 'alpha': 6.935982673484009, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.04498850544813846, 'n\_estimators': 800, 'max\_depth': 6, 'min\_child\_weight': 156}. Best is trial 88 with 0.07543383386945227.

[I 2025-11-03 11:52:38,395] Trial 90 finished with value: 0.0755527916827488 and parameters: {'lambda': 0.0010963099025653562, 'alpha': 7.416444956640115, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.044832357342328634, 'n\_estimators': 700, 'max\_depth': 5, 'min\_child\_weight': 130}. Best is trial 88 with 0.07543383386945227.

[I 2025-11-03 11:52:43,247] Trial 91 finished with value: 0.07545006256016064 and parameters: {'lambda': 0.001198411756128778, 'alpha': 3.863267342719101, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.0376213073369249, 'n\_estimators': 800, 'max\_depth': 6, 'min\_child\_weight': 158}. Best is trial 88 with 0.07543383386945227.

[I 2025-11-03 11:52:48,090] Trial 92 finished with value: 0.07544058901355276 and parameters: {'lambda': 0.0010278295567489864, 'alpha': 3.538921392716797, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.044656099614041045, 'n\_estimators': 800, 'max\_depth': 6, 'min\_child\_weight': 155}. Best is trial 88 with 0.07543383386945227.

[I 2025-11-03 11:52:52,973] Trial 93 finished with value: 0.0754664241665727 and parameters: {'lambda': 0.0010290149817806038, 'alpha': 3.836445741846956, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.043255911964921005, 'n\_estimators': 800, 'max\_depth': 6, 'min\_child\_weight': 156}. Best is trial 88 with 0.07543383386945227.

[I 2025-11-03 11:52:57,771] Trial 94 finished with value: 0.07546681328074299 and parameters: {'lambda': 0.001257448959920604, 'alpha': 2.0614351182692117, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.04538779760586936, 'n\_estimators': 800, 'max\_depth': 6, 'min\_child\_weight': 158}. Best is trial 88 with 0.07543383386945227.

[I 2025-11-03 11:53:02,630] Trial 95 finished with value: 0.07547565168688347 and parameters: {'lambda': 0.001638665316200091, 'alpha': 2.796355106060103, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.03929044283462736, 'n\_estimators': 800, 'max\_depth': 6, 'min\_child\_weight': 140}. Best is trial 88 with 0.07543383386945227.

[I 2025-11-03 11:53:06,398] Trial 96 finished with value: 0.07563121099516724 and parameters: {'lambda': 0.0012272616440522765, 'alpha': 4.024456068581073, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.03283156221479517, 'n\_estimators': 700, 'max\_depth': 5, 'min\_child\_weight': 169}. Best is trial 88 with 0.07543383386945227.

[I 2025-11-03 11:53:11,326] Trial 97 finished with value: 0.07544310331099373 and parameters: {'lambda': 0.001895275622628147, 'alpha': 7.054901213944029, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.04291930449420755, 'n\_estimators': 800, 'max\_depth': 6, 'min\_child\_weight': 152}. Best is trial 88 with 0.07543383386945227.

[I 2025-11-03 11:53:15,122] Trial 98 finished with value: 0.0755731337185795 and parameters: {'lambda': 0.0028664399735499886, 'alpha': 6.802661305760163, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.04277020514044308, 'n\_estimators': 700, 'max\_depth': 5, 'min\_child\_weight': 153}. Best is trial 88 with 0.07543383386945227.

[I 2025-11-03 11:53:20,115] Trial 99 finished with value: 0.07543592059859212 and parameters: {'lambda': 0.0020094418567702704, 'alpha': 9.95866532775105, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.0471678637838157, 'n\_estimators': 800, 'max\_depth': 6, 'min\_child\_weight': 136}. Best is trial 88 with 0.07543383386945227.

[I 2025-11-03 11:53:23,842] Trial 100 finished with value: 0.07576887296914907 and parameters: {'lambda': 0.0018788776914712803, 'alpha': 4.983684491655465, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.04888205861569921, 'n\_estimators': 800, 'max\_depth': 4, 'min\_child\_weight': 141}. Best is trial 88 with 0.07543383386945227.

[I 2025-11-03 11:53:28,776] Trial 101 finished with value: 0.07545534807669729 and parameters: {'lambda': 0.0010457831394634525, 'alpha': 9.259039919002813, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.04483772670545332, 'n\_estimators': 800, 'max\_depth': 6, 'min\_child\_weight': 179}. Best is trial 88 with 0.07543383386945227.

[I 2025-11-03 11:53:33,746] Trial 102 finished with value: 0.0754613608991307 and parameters: {'lambda': 0.0017686534534076457, 'alpha': 9.931979976397209, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.04686545915060778, 'n\_estimators': 800, 'max\_depth': 6, 'min\_child\_weight': 164}. Best is trial 88 with 0.07543383386945227.

[I 2025-11-03 11:53:38,593] Trial 103 finished with value: 0.07547939768205962 and parameters: {'lambda': 0.003357200451561029, 'alpha': 1.949465392445557, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.038962607772742915, 'n\_estimators': 800, 'max\_depth': 6, 'min\_child\_weight': 175}. Best is trial 88 with 0.07543383386945227.

[I 2025-11-03 11:53:42,372] Trial 104 finished with value: 0.07557478223360074 and parameters: {'lambda': 0.0010578831093600648, 'alpha': 8.299013890779136, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.04451685171019686, 'n\_estimators': 700, 'max\_depth': 5, 'min\_child\_weight': 144}. Best is trial 88 with 0.07543383386945227.

[I 2025-11-03 11:53:47,130] Trial 105 finished with value: 0.07549843237770966 and parameters: {'lambda': 0.0020885625405393333, 'alpha': 1.2474520426298379, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.04117038601518455, 'n\_estimators': 800, 'max\_depth': 6, 'min\_child\_weight': 137}. Best is trial 88 with 0.07543383386945227.

[I 2025-11-03 11:53:51,967] Trial 106 finished with value: 0.07546286547569014 and parameters: {'lambda': 0.0028015915299481327, 'alpha': 3.2752504771787345, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.0493973475500586, 'n\_estimators': 800, 'max\_depth': 6, 'min\_child\_weight': 151}. Best is trial 88 with 0.07543383386945227.

[I 2025-11-03 11:53:55,724] Trial 107 finished with value: 0.07557781837637163 and parameters: {'lambda': 0.0010023622278260112, 'alpha': 6.183896793479452, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.04627991107910956, 'n\_estimators': 700, 'max\_depth': 5, 'min\_child\_weight': 189}. Best is trial 88 with 0.07543383386945227.

[I 2025-11-03 11:54:00,639] Trial 108 finished with value: 0.07543852912884763 and parameters: {'lambda': 0.0018707392192610795, 'alpha': 4.558819586778219, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.04300425721313251, 'n\_estimators': 800, 'max\_depth': 6, 'min\_child\_weight': 122}. Best is trial 88 with 0.07543383386945227.

[I 2025-11-03 11:54:05,500] Trial 109 finished with value: 0.07543968529228219 and parameters: {'lambda': 0.0018278896005272719, 'alpha': 4.365819445212665, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.03363670555377305, 'n\_estimators': 800, 'max\_depth': 6, 'min\_child\_weight': 120}. Best is trial 88 with 0.07543383386945227.

[I 2025-11-03 11:54:09,742] Trial 110 finished with value: 0.07559270566675105 and parameters: {'lambda': 0.0019199686034280894, 'alpha': 4.375329975384312, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.03453411413573527, 'n\_estimators': 800, 'max\_depth': 5, 'min\_child\_weight': 122}. Best is trial 88 with 0.07543383386945227.



[I 2025-11-03 11:54:14,607] Trial 111 finished with value: 0.07546824550040244 and parameters: {'lambda': 0.001640129247861699, 'alpha': 2.425335853780864, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.039700121924459396, 'n\_estimators': 800, 'max\_depth': 6, 'min\_child\_weight': 112}. Best is trial 88 with 0.07543383386945227.

[I 2025-11-03 11:54:19,507] Trial 112 finished with value: 0.07544475438219797 and parameters: {'lambda': 0.002556041622207296, 'alpha': 5.083853353981672, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.0375451905230635, 'n\_estimators': 800, 'max\_depth': 6, 'min\_child\_weight': 134}. Best is trial 88 with 0.07543383386945227.

[I 2025-11-03 11:54:24,399] Trial 113 finished with value: 0.07542774932326271 and parameters: {'lambda': 0.0032393300857326353, 'alpha': 5.238383175579375, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.04194687589583582, 'n\_estimators': 800, 'max\_depth': 6, 'min\_child\_weight': 125}. Best is trial 113 with value: 0.07542774932326271.

[I 2025-11-03 11:54:29,310] Trial 114 finished with value: 0.07543434613794403 and parameters: {'lambda': 0.0037163808917955437, 'alpha': 5.365237914058634, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.04199939398521717, 'n\_estimators': 800, 'max\_depth': 6, 'min\_child\_weight': 122}. Best is trial 113 with value: 0.07542774932326271.

[I 2025-11-03 11:54:34,418] Trial 115 finished with value: 0.07548796292783294 and parameters: {'lambda': 0.004108030406475701, 'alpha': 5.0107264235054, 'colsample\_bytree': 0.9, 'subsample': 0.6, 'learning\_rate': 0.04103459404969611, 'n\_estimators': 700, 'max\_depth': 7, 'min\_child\_weight': 122}. Best is trial 113 with value: 0.07542774932326271.

[I 2025-11-03 11:54:39,258] Trial 116 finished with value: 0.07545706537537028 and parameters: {'lambda': 0.002999838733637548, 'alpha': 2.7465890137074394, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.04284137403942804, 'n\_estimators': 800, 'max\_depth': 6, 'min\_child\_weight': 102}. Best is trial 113 with value: 0.07542774932326271.

[I 2025-11-03 11:54:44,150] Trial 117 finished with value: 0.07549023952548042 and parameters: {'lambda': 0.0027236856913089745, 'alpha': 1.6086859876435307, 'colsample\_bytree': 0.9, 'subsample': 1.0, 'learning\_rate': 0.03348626346351351, 'n\_estimators': 700, 'max\_depth': 7, 'min\_child\_weight': 125}. Best is trial 113 with value: 0.07542774932326271.

[I 2025-11-03 11:54:49,094] Trial 118 finished with value: 0.0754540919174556 and parameters: {'lambda': 0.003458522515133299, 'alpha': 4.476901059071943, 'colsample\_bytree': 0.9, 'subsample': 0.7, 'learning\_rate': 0.049971519731671174, 'n\_estimators': 800, 'max\_depth': 6, 'min\_child\_weight': 94}. Best is trial 113 with 0.07542774932326271.

[I 2025-11-03 11:54:54,737] Trial 119 finished with value: 0.07612454818583637 and parameters: {'lambda': 0.0019797493325732496, 'alpha': 3.1620779994102977, 'colsample\_bytree': 0.3, 'subsample': 0.8, 'learning\_rate': 0.047007490669679235, 'n\_estimators': 800, 'max\_depth': 7, 'min\_child\_weight': 114}. Best is trial 113 with value: 0.07542774932326271.

[I 2025-11-03 11:54:59,505] Trial 120 finished with value: 0.07551865322456094 and parameters: {'lambda': 0.004810832707834621, 'alpha': 5.470198642213711, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.0426742969541748, 'n\_estimators': 900, 'max\_depth': 5, 'min\_child\_weight': 136}. Best is trial 113 with value: 0.07542774932326271.

[I 2025-11-03 11:55:04,465] Trial 121 finished with value: 0.0754460899101301 and parameters: {'lambda': 0.002381880979462075, 'alpha': 7.990442020639959, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.0362995432792703, 'n\_estimators': 800, 'max\_depth': 6, 'min\_child\_weight': 147}. Best is trial 113 with value: 0.07542774932326271.

[I 2025-11-03 11:55:09,421] Trial 122 finished with value: 0.07543824738706187 and parameters: {'lambda': 0.0036113455855617603, 'alpha': 6.037724173911884, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.03866392330024496, 'n\_estimators': 800, 'max\_depth': 6, 'min\_child\_weight': 132}. Best is trial 113 with value: 0.07542774932326271.

[I 2025-11-03 11:55:14,359] Trial 123 finished with value: 0.07542682271650097 and parameters: {'lambda': 0.003534147731403593, 'alpha': 5.48185561525784, 'colsample\_by': 0.9, 'subsample': 0.8, 'learning\_rate': 0.039152021634529535, 'n\_estimators': 800, 'max\_depth': 6, 'min\_child\_weight': 133}. Best is trial 123 with value: 0.07542682271650097.

[I 2025-11-03 11:55:19,268] Trial 124 finished with value: 0.07545586307776408 and parameters: {'lambda': 0.0034327104724535176, 'alpha': 3.5997531021864018, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.04000644544952574, 'n\_estimators': 800, 'max\_depth': 6, 'min\_child\_weight': 127}. Best is trial 123 with value: 0.07542682271650097.

[I 2025-11-03 11:55:24,785] Trial 125 finished with value: 0.07544813674974243 and parameters: {'lambda': 0.07736557701334384, 'alpha': 8.044864637068406, 'colsample\_by': 0.9, 'subsample': 0.8, 'learning\_rate': 0.041475394293779846, 'n\_estimators': 900, 'max\_depth': 6, 'min\_child\_weight': 107}. Best is trial 123 with value: 0.07542682271650097.

[I 2025-11-03 11:55:30,529] Trial 126 finished with value: 0.07554216541396733 and parameters: {'lambda': 0.0015832130221086502, 'alpha': 6.197047079784667, 'colsample\_bytree': 0.5, 'subsample': 0.8, 'learning\_rate': 0.03864285566863813, 'n\_estimators': 800, 'max\_depth': 7, 'min\_child\_weight': 118}. Best is trial 123 with value: 0.07542682271650097.

[I 2025-11-03 11:55:34,758] Trial 127 finished with value: 0.07552722035045017 and parameters: {'lambda': 0.004084835770310023, 'alpha': 4.277208524947031, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.04779406924014472, 'n\_estimators': 800, 'max\_depth': 5, 'min\_child\_weight': 146}. Best is trial 123 with value: 0.07542682271650097.

[I 2025-11-03 11:55:38,526] Trial 128 finished with value: 0.07560441361247587 and parameters: {'lambda': 0.0050592211876267345, 'alpha': 2.018185000446964, 'colsample\_bytree': 0.7, 'subsample': 0.8, 'learning\_rate': 0.034618227197762357, 'n\_estimators': 600, 'max\_depth': 6, 'min\_child\_weight': 132}. Best is trial 123 with value: 0.07542682271650097.

[I 2025-11-03 11:55:43,408] Trial 129 finished with value: 0.07545916254966267 and parameters: {'lambda': 0.0018656500747272415, 'alpha': 2.6607232598136688, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.044917631182786834, 'n\_estimators': 800, 'max\_depth': 6, 'min\_child\_weight': 105}. Best is trial 123 with value: 0.07542682271650097.

[I 2025-11-03 11:55:49,280] Trial 130 finished with value: 0.07546474646781007 and parameters: {'lambda': 0.003205059285955083, 'alpha': 6.968258782064399, 'colsample\_bytree': 0.9, 'subsample': 0.6, 'learning\_rate': 0.031572096709127286, 'n\_estimators': 800, 'max\_depth': 7, 'min\_child\_weight': 116}. Best is trial 123 with value: 0.07542682271650097.

[I 2025-11-03 11:55:54,200] Trial 131 finished with value: 0.0754392837003136 and parameters: {'lambda': 0.002487590170991677, 'alpha': 5.176758011828026, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.03746576293773105, 'n\_estimators': 800, 'max\_depth': 6, 'min\_child\_weight': 133}. Best is trial 123 with value: 0.07542682271650097.

[I 2025-11-03 11:55:59,121] Trial 132 finished with value: 0.07543282754225909 and parameters: {'lambda': 0.0014578235125047494, 'alpha': 5.360952790443867, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.041893624238448224, 'n\_estimators': 800, 'max\_depth': 6, 'min\_child\_weight': 130}. Best is trial 123 with value: 0.07542682271650097.

[I 2025-11-03 11:56:03,480] Trial 133 finished with value: 0.0754587321124379 and parameters: {'lambda': 0.0014235233618700013, 'alpha': 5.217266060648301, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.039597869587819065, 'n\_estimators': 700, 'max\_depth': 6, 'min\_child\_weight': 126}. Best is trial 123 with value: 0.07542682271650097.

[I 2025-11-03 11:56:09,023] Trial 134 finished with value: 0.07545588524730076 and parameters: {'lambda': 0.0021374676238526446, 'alpha': 9.68933877502029, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.04123284693479501, 'n\_estimators': 900, 'max\_depth': 6, 'min\_child\_weight': 137}. Best is trial 123 with value: 0.07542682271650097.

[I 2025-11-03 11:56:13,345] Trial 135 finished with value: 0.07546157230994865 and parameters: {'lambda': 0.0014449731454938672, 'alpha': 3.108042113578716, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.04623306578859289, 'n\_estimators': 700, 'max\_depth': 6, 'min\_child\_weight': 129}. Best is trial 123 with value: 0.07542682271650097.

[I 2025-11-03 11:56:17,492] Trial 136 finished with value: 0.07561751331941413 and parameters: {'lambda': 0.04995180263891117, 'alpha': 4.202968026482378, 'colsample\_bytree': 0.9, 'subsample': 1.0, 'learning\_rate': 0.03788048126958801, 'n\_estimators': 800, 'max\_depth': 5, 'min\_child\_weight': 143}. Best is trial 123 with value: 0.07542682271650097.

[I 2025-11-03 11:56:22,632] Trial 137 finished with value: 0.07574100484677886 and parameters: {'lambda': 0.0025412524377711335, 'alpha': 5.653505130387016, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.009532719724749368, 'n\_estimators': 800, 'max\_depth': 6, 'min\_child\_weight': 85}. Best is trial 123 with value: 0.07542682271650097.

[I 2025-11-03 11:56:28,466] Trial 138 finished with value: 0.07544070687318234 and parameters: {'lambda': 0.0016520155203588159, 'alpha': 3.8728032031985338, 'colsample\_bytree': 0.9, 'subsample': 0.7, 'learning\_rate': 0.035342937297285944, 'n\_estimators': 800, 'max\_depth': 7, 'min\_child\_weight': 110}. Best is trial 123 with value: 0.07542682271650097.

[I 2025-11-03 11:56:34,285] Trial 139 finished with value: 0.07615656117991924 and parameters: {'lambda': 0.0014440073801230428, 'alpha': 4.453122466974797, 'colsample\_bytree': 0.3, 'subsample': 0.7, 'learning\_rate': 0.043171774159328526, 'n\_estimators': 800, 'max\_depth': 7, 'min\_child\_weight': 118}. Best is trial 123 with value: 0.07542682271650097.

[I 2025-11-03 11:56:40,728] Trial 140 finished with value: 0.07550454072802285 and parameters: {'lambda': 0.0035883092185911483, 'alpha': 0.8110375391510388, 'colsample\_bytree': 0.9, 'subsample': 0.7, 'learning\_rate': 0.03517883116267395, 'n\_estimators': 900, 'max\_depth': 7, 'min\_child\_weight': 97}. Best is trial 123 with value: 0.07542682271650097.

[I 2025-11-03 11:56:45,845] Trial 141 finished with value: 0.07543836313999787 and parameters: {'lambda': 0.0016696341277336033, 'alpha': 5.674690849307508, 'colsample\_bytree': 0.9, 'subsample': 0.7, 'learning\_rate': 0.04002981623566835, 'n\_estimators': 800, 'max\_depth': 6, 'min\_child\_weight': 107}. Best is trial 123 with value: 0.07542682271650097.

[I 2025-11-03 11:56:50,911] Trial 142 finished with value: 0.07544802398727073 and parameters: {'lambda': 8.135029902905654, 'alpha': 5.948125600215911, 'colsample\_bytree': 0.9, 'subsample': 0.7, 'learning\_rate': 0.03979731359024039, 'n\_estimators': 800, 'max\_depth': 6, 'min\_child\_weight': 123}. Best is trial 123 with value: 0.07542682271650097.

[I 2025-11-03 11:56:56,017] Trial 143 finished with value: 0.07544879334973069 and parameters: {'lambda': 0.0017444365753856814, 'alpha': 8.063467221066656, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.0325583927035289, 'n\_estimators': 800, 'max\_depth': 6, 'min\_child\_weight': 110}. Best is trial 123 with value: 0.07542682271650097.

[I 2025-11-03 11:57:01,065] Trial 144 finished with value: 0.07545521405608982 and parameters: {'lambda': 0.0011710188327730248, 'alpha': 4.872803291062176, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.041663439780334065, 'n\_estimators': 800, 'max\_depth': 6, 'min\_child\_weight': 135}. Best is trial 123 with value: 0.07542682271650097.

[I 2025-11-03 11:57:05,361] Trial 145 finished with value: 0.07554134213534207 and parameters: {'lambda': 0.0029092338904771827, 'alpha': 3.5755950959879836, 'colsample\_bytree': 0.9, 'subsample': 0.7, 'learning\_rate': 0.045120120540848165, 'n\_estimators': 800, 'max\_depth': 5, 'min\_child\_weight': 102}. Best is trial 123 with value: 0.07542682271650097.

[I 2025-11-03 11:57:10,251] Trial 146 finished with value: 0.07560026648901143 and parameters: {'lambda': 0.0023010243788545515, 'alpha': 6.826936141664452, 'colsample\_bytree': 0.5, 'subsample': 0.7, 'learning\_rate': 0.04695887110923523, 'n\_estimators': 800, 'max\_depth': 6, 'min\_child\_weight': 162}. Best is trial 123 with value: 0.07542682271650097.

[I 2025-11-03 11:57:14,531] Trial 147 finished with value: 0.07548913420040405 and parameters: {'lambda': 0.001620083568600805, 'alpha': 2.3400350576855815, 'colsample\_bytree': 0.9, 'subsample': 0.7, 'learning\_rate': 0.038029139936966064, 'n\_estimators': 700, 'max\_depth': 6, 'min\_child\_weight': 129}. Best is trial 123 with value: 0.07542682271650097.

[I 2025-11-03 11:57:19,531] Trial 148 finished with value: 0.07546771129644467 and parameters: {'lambda': 0.0013022981192570568, 'alpha': 9.896659731385986, 'colsample\_bytree': 0.9, 'subsample': 0.7, 'learning\_rate': 0.044136785884713106, 'n\_estimators': 800, 'max\_depth': 6, 'min\_child\_weight': 149}. Best is trial 123 with value: 0.07542682271650097.

[I 2025-11-03 11:57:25,341] Trial 149 finished with value: 0.07551176406156086 and parameters: {'lambda': 0.006760373865711497, 'alpha': 5.762365581336551, 'colsample\_bytree': 0.9, 'subsample': 0.7, 'learning\_rate': 0.04987527130301579, 'n\_estimators': 800, 'max\_depth': 7, 'min\_child\_weight': 142}. Best is trial 123 with value: 0.07542682271650097.

[I 2025-11-03 11:57:25,343] A new study created in memory with name: no-name-1cc50844-2990-49c4-b111-bdca062730f3

✓ Best XGBRegressor parameters: {'lambda': 0.003534147731403593, 'alpha': 5.48185561525784, 'colsample\_bytree': 0.9, 'subsample': 0.8, 'learning\_rate': 0.039152021634529535, 'n\_estimators': 800, 'max\_depth': 6, 'min\_child\_weight': 133}

🔧 Tuning LGBMRegressor (GPU)...



[illegible]

0.6280480698717317, 'bagging\_freq': 1, 'min\_child\_samples': 74, 'learning\_rate': 0.007264433808803609, 'n\_estimators': 600, 'max\_depth': 7}. Best is trial 0 with value 0.07560926477605637.

[I 2025-11-03 11:59:36,976] Trial 5 finished with value: 0.07569192800817018 and parameters: {'lambda\_l1': 0.19958861714640896, 'lambda\_l2': 0.021359971703854216, 'num\_leaves': 244, 'feature\_fraction': 0.8352843689047195, 'bagging\_fraction': 0.9235643411080903, 'bagging\_freq': 6, 'min\_child\_samples': 76, 'learning\_rate': 0.007917717659353748, 'n\_estimators': 500, 'max\_depth': 11}. Best is trial 0 with value 0.07560926477605637.

[I 2025-11-03 11:59:49,297] Trial 6 finished with value: 0.07570799895039769 and parameters: {'lambda\_l1': 0.002430468717182398, 'lambda\_l2': 0.00013978352369222176, 'num\_leaves': 133, 'feature\_fraction': 0.8761183321859417, 'bagging\_fraction': 0.5736347251507399, 'bagging\_freq': 6, 'min\_child\_samples': 68, 'learning\_rate': 0.047789517149801626, 'n\_estimators': 500, 'max\_depth': 5}. Best is trial 0 with value 0.07560926477605637.

[I 2025-11-03 12:00:10,488] Trial 7 finished with value: 0.07545940108829521 and parameters: {'lambda\_l1': 4.227375969561634e-05, 'lambda\_l2': 0.011486765927675915, 'num\_leaves': 219, 'feature\_fraction': 0.897772364407488, 'bagging\_fraction': 0.5895499618953145, 'bagging\_freq': 1, 'min\_child\_samples': 87, 'learning\_rate': 0.014093076438132771, 'n\_estimators': 500, 'max\_depth': 8}. Best is trial 7 with value 0.07545940108829521.

[I 2025-11-03 12:00:19,112] Trial 8 finished with value: 0.07566497697211891 and parameters: {'lambda\_l1': 0.025517945882313094, 'lambda\_l2': 0.05859823224577603, 'num\_leaves': 77, 'feature\_fraction': 0.7466761866244227, 'bagging\_fraction': 0.8739164486699087, 'bagging\_freq': 2, 'min\_child\_samples': 96, 'learning\_rate': 0.11247532820725366, 'n\_estimators': 200, 'max\_depth': 10}. Best is trial 7 with value 0.07545940108829521.

[I 2025-11-03 12:00:23,584] Trial 9 finished with value: 0.08527355711959932 and parameters: {'lambda\_l1': 0.001308757327944223, 'lambda\_l2': 0.33750642574763223, 'num\_leaves': 23, 'feature\_fraction': 0.7024519378565897, 'bagging\_fraction': 0.5810415510039411, 'bagging\_freq': 1, 'min\_child\_samples': 97, 'learning\_rate': 0.008935275055047438, 'n\_estimators': 200, 'max\_depth': 4}. Best is trial 7 with value 0.07545940108829521.

[I 2025-11-03 12:01:16,521] Trial 10 finished with value: 0.07576421060798995 and parameters: {'lambda\_l1': 0.0001635047226253495, 'lambda\_l2': 1.2438505848135959e-05, 'num\_leaves': 179, 'feature\_fraction': 0.9896107897095568, 'bagging\_fraction': 0.5124547888910852, 'bagging\_freq': 4, 'min\_child\_samples': 40, 'learning\_rate': 0.018841114946942832, 'n\_estimators': 1000, 'max\_depth': 9}. Best is trial 7 with value 0.07545940108829521.

[I 2025-11-03 12:01:32,601] Trial 11 finished with value: 0.07911303163645225 and parameters: {'lambda\_l1': 0.0003351678474543958, 'lambda\_l2': 0.0018929260587246183, 'num\_leaves': 124, 'feature\_fraction': 0.8205328472600467, 'bagging\_fraction': 0.7283152907386758, 'bagging\_freq': 4, 'min\_child\_samples': 11, 'learning\_rate': 0.2919845846754109, 'n\_estimators': 400, 'max\_depth': 7}. Best is trial 7 with value 0.07545940108829521.

[I 2025-11-03 12:01:55,942] Trial 12 finished with value: 0.07555695952464149 and parameters: {'lambda\_l1': 0.0004519985319351651, 'lambda\_l2': 0.00021968743488716516, 'num\_leaves': 191, 'feature\_fraction': 0.9929615194385828, 'bagging\_fraction': 0.7965448728016546, 'bagging\_freq': 7, 'min\_child\_samples': 33, 'learning\_rate': 0.022381256423462982, 'n\_estimators': 700, 'max\_depth': 6}. Best is trial 7 with value 0.07545940108829521.

[I 2025-11-03 12:02:45,268] Trial 13 finished with value: 0.07555707122919132 and parameters: {'lambda\_l1': 0.011614759477052369, 'lambda\_l2': 0.02472098788999028, 'num\_leaves': 173, 'feature\_fraction': 0.9998294888642362, 'bagging\_fraction': 0.8350415190304791, 'bagging\_freq': 7, 'min\_child\_samples': 32, 'learning\_rate': 0.021457015786340846, 'n\_estimators': 1000, 'max\_depth': 8}. Best is trial 7 with value 0.07545940108829521.

[I 2025-11-03 12:02:52,707] Trial 14 finished with value: 0.07740501052692644 and parameters: {'lambda\_l1': 3.819683625627087e-05, 'lambda\_l2': 0.000598427733318118, 'num\_leaves': 198, 'feature\_fraction': 0.9261178493931792, 'bagging\_fraction':

0.6779741322535165, 'bagging\_freq': 6, 'min\_child\_samples': 37, 'learning\_rate': 0.02198135280166261, 'n\_estimators': 400, 'max\_depth': 3}. Best is trial 7 with value 0.07545940108829521.

[I 2025-11-03 12:03:31,859] Trial 15 finished with value: 0.07550236419630119 and parameters: {'lambda\_l1': 0.0001564818100174955, 'lambda\_l2': 0.007789084585210438, 'num\_leaves': 196, 'feature\_fraction': 0.9305529343565211, 'bagging\_fraction': 0.9930948950041772, 'bagging\_freq': 7, 'min\_child\_samples': 56, 'learning\_rate': 0.014916505728895496, 'n\_estimators': 700, 'max\_depth': 8}. Best is trial 7 with value 0.07545940108829521.

[I 2025-11-03 12:04:20,518] Trial 16 finished with value: 0.0755270375432027 and parameters: {'lambda\_l1': 1.3364914062451719e-05, 'lambda\_l2': 0.008720374217769326, 'num\_leaves': 158, 'feature\_fraction': 0.5034220473004176, 'bagging\_fraction': 0.9886775623840726, 'bagging\_freq': 5, 'min\_child\_samples': 58, 'learning\_rate': 0.012537319481056542, 'n\_estimators': 800, 'max\_depth': 9}. Best is trial 7 with value 0.07545940108829521.

[I 2025-11-03 12:04:46,938] Trial 17 finished with value: 0.0779139271673493 and parameters: {'lambda\_l1': 0.0001278171886195823, 'lambda\_l2': 0.09144519411348084, 'num\_leaves': 208, 'feature\_fraction': 0.9201857582760355, 'bagging\_fraction': 0.8732411455411812, 'bagging\_freq': 3, 'min\_child\_samples': 85, 'learning\_rate': 0.005126556451853236, 'n\_estimators': 400, 'max\_depth': 8}. Best is trial 7 with value 0.07545940108829521.

[I 2025-11-03 12:05:12,138] Trial 18 finished with value: 0.07563963170941855 and parameters: {'lambda\_l1': 0.5098447063747533, 'lambda\_l2': 0.006809927342694874, 'num\_leaves': 101, 'feature\_fraction': 0.8765313021296084, 'bagging\_fraction': 0.5139187428604106, 'bagging\_freq': 5, 'min\_child\_samples': 59, 'learning\_rate': 0.035632642573029415, 'n\_estimators': 600, 'max\_depth': 10}. Best is trial 7 with value 0.07545940108829521.

[I 2025-11-03 12:06:04,913] Trial 19 finished with value: 0.07590939138806153 and parameters: {'lambda\_l1': 6.969912486506857e-05, 'lambda\_l2': 0.14582216844621101, 'num\_leaves': 217, 'feature\_fraction': 0.9421450111467948, 'bagging\_fraction': 0.6247609815459327, 'bagging\_freq': 3, 'min\_child\_samples': 47, 'learning\_rate': 0.03310305086739223, 'n\_estimators': 900, 'max\_depth': 9}. Best is trial 7 with value 0.07545940108829521.

[I 2025-11-03 12:06:25,560] Trial 20 finished with value: 0.07577703577083268 and parameters: {'lambda\_l1': 0.01706672006967326, 'lambda\_l2': 0.7877600609580313, 'num\_leaves': 159, 'feature\_fraction': 0.7761178522568785, 'bagging\_fraction': 0.7153239541859803, 'bagging\_freq': 2, 'min\_child\_samples': 88, 'learning\_rate': 0.014423664665192824, 'n\_estimators': 500, 'max\_depth': 6}. Best is trial 7 with value 0.07545940108829521.

[I 2025-11-03 12:07:13,810] Trial 21 finished with value: 0.07545515437099608 and parameters: {'lambda\_l1': 1.1798735649463315e-05, 'lambda\_l2': 0.009617503997806458, 'num\_leaves': 156, 'feature\_fraction': 0.5600450176129735, 'bagging\_fraction': 0.9766914251320564, 'bagging\_freq': 5, 'min\_child\_samples': 68, 'learning\_rate': 0.013274849548315516, 'n\_estimators': 800, 'max\_depth': 9}. Best is trial 21 with value 0.07545515437099608.

[I 2025-11-03 12:07:56,461] Trial 22 finished with value: 0.07651134160162372 and parameters: {'lambda\_l1': 2.4679131891466287e-05, 'lambda\_l2': 0.019973429999461667, 'num\_leaves': 152, 'feature\_fraction': 0.6343448306956347, 'bagging\_fraction': 0.9985903495839528, 'bagging\_freq': 5, 'min\_child\_samples': 69, 'learning\_rate': 0.005237288777912771, 'n\_estimators': 700, 'max\_depth': 8}. Best is trial 21 with value 0.07545515437099608.

[I 2025-11-03 12:08:51,574] Trial 23 finished with value: 0.07545688085434403 and parameters: {'lambda\_l1': 1.002770632998573e-05, 'lambda\_l2': 0.0058310905725783655, 'num\_leaves': 184, 'feature\_fraction': 0.5034734529278171, 'bagging\_fraction': 0.9187550636682644, 'bagging\_freq': 7, 'min\_child\_samples': 63, 'learning\_rate': 0.01552517495343576, 'n\_estimators': 900, 'max\_depth': 10}. Best is trial 21 with value 0.07545515437099608.

[I 2025-11-03 12:09:37,263] Trial 24 finished with value: 0.07555191915745807 and parameters: {'lambda\_l1': 1.050052642255844e-05, 'lambda\_l2': 0.03986572575128757, 'num\_leaves': 107, 'feature\_fraction': 0.5029363566210796, 'bagging\_fraction':

0.9015264893667942, 'bagging\_freq': 6, 'min\_child\_samples': 67, 'learning\_rate': 0.011095963633110197, 'n\_estimators': 900, 'max\_depth': 10}. Best is trial 21 with value 0.07545515437099608.

[I 2025-11-03 12:10:27,078] Trial 25 finished with value: 0.0755883102012957 and parameters: {'lambda\_l1': 3.2895847797440415e-05, 'lambda\_l2': 0.0008044635035229916, 'num\_leaves': 167, 'feature\_fraction': 0.5447234746487869, 'bagging\_fraction': 0.9353399350493714, 'bagging\_freq': 5, 'min\_child\_samples': 90, 'learning\_rate': 0.029431639502772198, 'n\_estimators': 900, 'max\_depth': 12}. Best is trial 21 with value 0.07545515437099608.

[I 2025-11-03 12:11:20,351] Trial 26 finished with value: 0.07541795054608819 and parameters: {'lambda\_l1': 2.2351412273199605e-05, 'lambda\_l2': 0.003513223088427626, 'num\_leaves': 146, 'feature\_fraction': 0.5664806437205567, 'bagging\_fraction': 0.8435044147718517, 'bagging\_freq': 7, 'min\_child\_samples': 78, 'learning\_rate': 0.016494344229249867, 'n\_estimators': 1000, 'max\_depth': 11}. Best is trial 26 with value 0.07541795054608819.

[I 2025-11-03 12:12:09,246] Trial 27 finished with value: 0.07556284763181839 and parameters: {'lambda\_l1': 1.6571194436661644e-05, 'lambda\_l2': 0.0036309229037999966, 'num\_leaves': 144, 'feature\_fraction': 0.5789706228201856, 'bagging\_fraction': 0.8437674755758938, 'bagging\_freq': 7, 'min\_child\_samples': 64, 'learning\_rate': 0.02726477937728679, 'n\_estimators': 1000, 'max\_depth': 11}. Best is trial 26 with value 0.07541795054608819.

[I 2025-11-03 12:12:47,329] Trial 28 finished with value: 0.07547128343062924 and parameters: {'lambda\_l1': 6.978686166471752e-05, 'lambda\_l2': 0.0005889666090845038, 'num\_leaves': 81, 'feature\_fraction': 0.6257635055751501, 'bagging\_fraction': 0.9559653484507937, 'bagging\_freq': 6, 'min\_child\_samples': 76, 'learning\_rate': 0.017846837259155274, 'n\_estimators': 900, 'max\_depth': 10}. Best is trial 26 with value 0.07541795054608819.

[I 2025-11-03 12:13:26,289] Trial 29 finished with value: 0.0760222790493825 and parameters: {'lambda\_l1': 0.0007991725624750689, 'lambda\_l2': 0.0022626794069268165, 'num\_leaves': 121, 'feature\_fraction': 0.5409681475899744, 'bagging\_fraction': 0.7792802771711672, 'bagging\_freq': 7, 'min\_child\_samples': 50, 'learning\_rate': 0.050160492777581396, 'n\_estimators': 1000, 'max\_depth': 12}. Best is trial 26 with value 0.07541795054608819.

[I 2025-11-03 12:14:01,101] Trial 30 finished with value: 0.07589985272171741 and parameters: {'lambda\_l1': 0.00033866136293663504, 'lambda\_l2': 1.669035104111272e-05, 'num\_leaves': 51, 'feature\_fraction': 0.6327757432896305, 'bagging\_fraction': 0.893876465525306, 'bagging\_freq': 4, 'min\_child\_samples': 79, 'learning\_rate': 0.00732311082135068, 'n\_estimators': 800, 'max\_depth': 11}. Best is trial 26 with value 0.07541795054608819.

[I 2025-11-03 12:14:58,500] Trial 31 finished with value: 0.07547857061555822 and parameters: {'lambda\_l1': 4.437278591155967e-05, 'lambda\_l2': 0.010362192665375143, 'num\_leaves': 183, 'feature\_fraction': 0.5463869610930516, 'bagging\_fraction': 0.9319784658458796, 'bagging\_freq': 6, 'min\_child\_samples': 83, 'learning\_rate': 0.009764620808072748, 'n\_estimators': 900, 'max\_depth': 9}. Best is trial 26 with value 0.07541795054608819.

[I 2025-11-03 12:15:17,983] Trial 32 finished with value: 0.0762057594696458 and parameters: {'lambda\_l1': 1.8566433694116452e-05, 'lambda\_l2': 0.014133194658661162, 'num\_leaves': 212, 'feature\_fraction': 0.5789026590291854, 'bagging\_fraction': 0.8318961819043758, 'bagging\_freq': 7, 'min\_child\_samples': 91, 'learning\_rate': 0.015231214568441523, 'n\_estimators': 300, 'max\_depth': 10}. Best is trial 26 with value 0.07541795054608819.

[I 2025-11-03 12:15:55,273] Trial 33 finished with value: 0.0754273072829397 and parameters: {'lambda\_l1': 2.4485253755244238e-05, 'lambda\_l2': 0.004326517144765142, 'num\_leaves': 143, 'feature\_fraction': 0.6079948677116089, 'bagging\_fraction': 0.9582289177803845, 'bagging\_freq': 2, 'min\_child\_samples': 72, 'learning\_rate': 0.026676379619335246, 'n\_estimators': 600, 'max\_depth': 9}. Best is trial 26 with value 0.07541795054608819.

[I 2025-11-03 12:16:38,902] Trial 34 finished with value: 0.07585400266157595 and parameters: {'lambda\_l1': 0.00010898138299340955, 'lambda\_l2': 0.001270809027155487, 'num\_leaves': 136, 'feature\_fraction': 0.6731395684900819, 'bagging\_fraction':



0.9659214367742378, 'bagging\_freq': 2, 'min\_child\_samples': 72, 'learning\_rate': 0.05221872216315782, 'n\_estimators': 800, 'max\_depth': 11}. Best is trial 26 with value 0.07541795054608819.

[I 2025-11-03 12:17:25,531] Trial 35 finished with value: 0.07546588785229054 and parameters: {'lambda\_l1': 2.307212887742621e-05, 'lambda\_l2': 0.000370495430550066, 'num\_leaves': 146, 'feature\_fraction': 0.5934611165168397, 'bagging\_fraction': 0.9003297982554466, 'bagging\_freq': 3, 'min\_child\_samples': 62, 'learning\_rate': 0.02432869560884282, 'n\_estimators': 800, 'max\_depth': 9}. Best is trial 26 with value 0.07541795054608819.

[I 2025-11-03 12:17:49,426] Trial 36 finished with value: 0.07584066341167392 and parameters: {'lambda\_l1': 1.0351584398685171e-05, 'lambda\_l2': 0.0041162188712708225, 'num\_leaves': 119, 'feature\_fraction': 0.5257264209600183, 'bagging\_fraction': 0.9545102405830058, 'bagging\_freq': 7, 'min\_child\_samples': 73, 'learning\_rate': 0.07146875397173154, 'n\_estimators': 600, 'max\_depth': 12}. Best is trial 26 with value 0.07541795054608819.

[I 2025-11-03 12:18:45,076] Trial 37 finished with value: 0.07591299727644786 and parameters: {'lambda\_l1': 0.053055600698921714, 'lambda\_l2': 0.004020803198197944, 'num\_leaves': 165, 'feature\_fraction': 0.6082421239884039, 'bagging\_fraction': 0.8599193932268651, 'bagging\_freq': 5, 'min\_child\_samples': 80, 'learning\_rate': 0.040880005920627176, 'n\_estimators': 1000, 'max\_depth': 11}. Best is trial 26 with value 0.07541795054608819.

[I 2025-11-03 12:19:33,940] Trial 38 finished with value: 0.07545008475090118 and parameters: {'lambda\_l1': 0.004628108137722367, 'lambda\_l2': 4.572052238279251e-05, 'num\_leaves': 233, 'feature\_fraction': 0.6652845838597985, 'bagging\_fraction': 0.9203699209697916, 'bagging\_freq': 6, 'min\_child\_samples': 48, 'learning\_rate': 0.010981090770902492, 'n\_estimators': 700, 'max\_depth': 10}. Best is trial 26 with value 0.07541795054608819.

[I 2025-11-03 12:20:08,611] Trial 39 finished with value: 0.07589847226529854 and parameters: {'lambda\_l1': 0.006626247733653186, 'lambda\_l2': 3.6035288827774567e-05, 'num\_leaves': 233, 'feature\_fraction': 0.7318324959228003, 'bagging\_fraction': 0.8166449877221361, 'bagging\_freq': 6, 'min\_child\_samples': 50, 'learning\_rate': 0.006557089074288534, 'n\_estimators': 700, 'max\_depth': 7}. Best is trial 26 with value 0.07541795054608819.

[I 2025-11-03 12:20:44,213] Trial 40 finished with value: 0.07559431649282813 and parameters: {'lambda\_l1': 0.0032252996505536197, 'lambda\_l2': 6.237298811454343e-05, 'num\_leaves': 98, 'feature\_fraction': 0.6632094599070288, 'bagging\_fraction': 0.9699030845551503, 'bagging\_freq': 5, 'min\_child\_samples': 27, 'learning\_rate': 0.011006130920110406, 'n\_estimators': 700, 'max\_depth': 9}. Best is trial 26 with value 0.07541795054608819.

[I 2025-11-03 12:21:40,204] Trial 41 finished with value: 0.0754438312299364 and parameters: {'lambda\_l1': 0.006206861616165317, 'lambda\_l2': 0.0012794485135469147, 'num\_leaves': 255, 'feature\_fraction': 0.5618674959875457, 'bagging\_fraction': 0.9055678514104559, 'bagging\_freq': 6, 'min\_child\_samples': 66, 'learning\_rate': 0.01641702866058906, 'n\_estimators': 800, 'max\_depth': 10}. Best is trial 26 with value 0.07541795054608819.

[I 2025-11-03 12:22:23,077] Trial 42 finished with value: 0.07550028903434984 and parameters: {'lambda\_l1': 0.006171108025151988, 'lambda\_l2': 0.0002798788031191813, 'num\_leaves': 255, 'feature\_fraction': 0.564976052652778, 'bagging\_fraction': 0.9410945297490213, 'bagging\_freq': 6, 'min\_child\_samples': 45, 'learning\_rate': 0.018428977143720254, 'n\_estimators': 600, 'max\_depth': 11}. Best is trial 26 with value 0.07541795054608819.

[I 2025-11-03 12:23:07,228] Trial 43 finished with value: 0.07557299671854904 and parameters: {'lambda\_l1': 0.0015879691856575744, 'lambda\_l2': 0.0024982312877860446, 'num\_leaves': 241, 'feature\_fraction': 0.6518886509775839, 'bagging\_fraction': 0.9107823568348918, 'bagging\_freq': 6, 'min\_child\_samples': 69, 'learning\_rate': 0.0091907278664867, 'n\_estimators': 600, 'max\_depth': 10}. Best is trial 26 with value 0.07541795054608819.

[I 2025-11-03 12:24:00,341] Trial 44 finished with value: 0.07541413131040026 and parameters: {'lambda\_l1': 0.04989171690578945, 'lambda\_l2': 0.0012960648609225047, 'num\_leaves': 233, 'feature\_fraction': 0.6113670863169267, 'bagging\_fraction':

0.8842242266951144, 'bagging\_freq': 5, 'min\_child\_samples': 76, 'learning\_rate': 0.012729839880967932, 'n\_estimators': 800, 'max\_depth': 9}. Best is trial 44 with value 0.07541413131040026.

[I 2025-11-03 12:24:48,131] Trial 45 finished with value: 0.07542369933301651 and parameters: {'lambda\_l1': 0.06924499135565058, 'lambda\_l2': 0.0011028878617833496, 'num\_leaves': 228, 'feature\_fraction': 0.69913461750472, 'bagging\_fraction': 0.8780334129094577, 'bagging\_freq': 6, 'min\_child\_samples': 78, 'learning\_rate': 0.017503216396523053, 'n\_estimators': 700, 'max\_depth': 10}. Best is trial 44 with value 0.07541413131040026.

[I 2025-11-03 12:25:44,506] Trial 46 finished with value: 0.07563394448173573 and parameters: {'lambda\_l1': 0.08207070180909753, 'lambda\_l2': 0.001219086074294138, 'num\_leaves': 241, 'feature\_fraction': 0.7119519125503934, 'bagging\_fraction': 0.8747449896678132, 'bagging\_freq': 4, 'min\_child\_samples': 75, 'learning\_rate': 0.027251828995770517, 'n\_estimators': 800, 'max\_depth': 11}. Best is trial 44 with value 0.07541413131040026.

[I 2025-11-03 12:26:12,771] Trial 47 finished with value: 0.08015465165874636 and parameters: {'lambda\_l1': 0.18816733537901734, 'lambda\_l2': 0.00012756380280016058, 'num\_leaves': 223, 'feature\_fraction': 0.6937321936621103, 'bagging\_fraction': 0.7514362620316594, 'bagging\_freq': 1, 'min\_child\_samples': 82, 'learning\_rate': 0.22518913153461342, 'n\_estimators': 600, 'max\_depth': 9}. Best is trial 44 with value 0.07541413131040026.

[I 2025-11-03 12:26:44,274] Trial 48 finished with value: 0.07546617095913204 and parameters: {'lambda\_l1': 0.047767557702501996, 'lambda\_l2': 0.0014828910106921159, 'num\_leaves': 256, 'feature\_fraction': 0.6127088014169376, 'bagging\_fraction': 0.8122015767051002, 'bagging\_freq': 6, 'min\_child\_samples': 78, 'learning\_rate': 0.018631277224581102, 'n\_estimators': 700, 'max\_depth': 7}. Best is trial 44 with value 0.07541413131040026.

[I 2025-11-03 12:27:10,257] Trial 49 finished with value: 0.07553309628231938 and parameters: {'lambda\_l1': 0.20848970582034282, 'lambda\_l2': 0.0010116839150036713, 'num\_leaves': 246, 'feature\_fraction': 0.5974661035765317, 'bagging\_fraction': 0.8516431621716737, 'bagging\_freq': 5, 'min\_child\_samples': 72, 'learning\_rate': 0.04117046394934381, 'n\_estimators': 500, 'max\_depth': 8}. Best is trial 44 with value 0.07541413131040026.

[I 2025-11-03 12:28:03,101] Trial 50 finished with value: 0.07548876863813853 and parameters: {'lambda\_l1': 0.021571295442035936, 'lambda\_l2': 0.0007414062362624962, 'num\_leaves': 207, 'feature\_fraction': 0.7897841268729152, 'bagging\_fraction': 0.8749676505064095, 'bagging\_freq': 4, 'min\_child\_samples': 94, 'learning\_rate': 0.022219398424251028, 'n\_estimators': 800, 'max\_depth': 10}. Best is trial 44 with value 0.07541413131040026.

[I 2025-11-03 12:28:52,700] Trial 51 finished with value: 0.07546132690051091 and parameters: {'lambda\_l1': 0.006243099027359898, 'lambda\_l2': 0.00037374848225292935, 'num\_leaves': 231, 'feature\_fraction': 0.6539992986481122, 'bagging\_fraction': 0.8867063404647567, 'bagging\_freq': 6, 'min\_child\_samples': 64, 'learning\_rate': 0.011291532761811314, 'n\_estimators': 700, 'max\_depth': 10}. Best is trial 44 with value 0.07541413131040026.

[I 2025-11-03 12:29:36,872] Trial 52 finished with value: 0.07554694605608539 and parameters: {'lambda\_l1': 0.00966028750486916, 'lambda\_l2': 0.0018608908229670843, 'num\_leaves': 228, 'feature\_fraction': 0.6823077238204448, 'bagging\_fraction': 0.9118226344083838, 'bagging\_freq': 6, 'min\_child\_samples': 18, 'learning\_rate': 0.017275416453488245, 'n\_estimators': 700, 'max\_depth': 11}. Best is trial 44 with value 0.07541413131040026.

[I 2025-11-03 12:30:27,396] Trial 53 finished with value: 0.07550166148444679 and parameters: {'lambda\_l1': 0.0019395825358774345, 'lambda\_l2': 2.385361438142068e-05, 'num\_leaves': 235, 'feature\_fraction': 0.7204787903685509, 'bagging\_fraction': 0.9450643490383693, 'bagging\_freq': 7, 'min\_child\_samples': 54, 'learning\_rate': 0.008542993717969634, 'n\_estimators': 700, 'max\_depth': 10}. Best is trial 44 with value 0.07541413131040026.

[I 2025-11-03 12:31:04,184] Trial 54 finished with value: 0.07550372797648368 and parameters: {'lambda\_l1': 0.000955089488421346, 'lambda\_l2': 0.00015067325684805317, 'num\_leaves': 247, 'feature\_fraction': 0.761316569539696, 'bagging\_fraction':

0.8623571921913918, 'bagging\_freq': 5, 'min\_child\_samples': 77, 'learning\_rate': 0.012978468014717382, 'n\_estimators': 500, 'max\_depth': 12}. Best is trial 44 with value 0.07541413131040026.

[I 2025-11-03 12:31:42,034] Trial 55 finished with value: 0.07544200693607851 and parameters: {'lambda\_l1': 0.033370861520128026, 'lambda\_l2': 0.005519643439454615, 'num\_leaves': 201, 'feature\_fraction': 0.642560042399876, 'bagging\_fraction': 0.9222431816551013, 'bagging\_freq': 6, 'min\_child\_samples': 85, 'learning\_rate': 0.02097358371779627, 'n\_estimators': 600, 'max\_depth': 9}. Best is trial 44 with value 0.07541413131040026.

[I 2025-11-03 12:32:16,501] Trial 56 finished with value: 0.07550588874148104 and parameters: {'lambda\_l1': 0.032807780496615216, 'lambda\_l2': 0.0043452772905535186, 'num\_leaves': 204, 'feature\_fraction': 0.6305892916047894, 'bagging\_fraction': 0.8258316626689246, 'bagging\_freq': 7, 'min\_child\_samples': 100, 'learning\_rate': 0.033226226125991354, 'n\_estimators': 600, 'max\_depth': 9}. Best is trial 44 with value 0.07541413131040026.

[I 2025-11-03 12:32:54,784] Trial 57 finished with value: 0.07542944021096597 and parameters: {'lambda\_l1': 0.11501990640692264, 'lambda\_l2': 0.002450968457637498, 'num\_leaves': 218, 'feature\_fraction': 0.5703942051589749, 'bagging\_fraction': 0.799482948596978, 'bagging\_freq': 4, 'min\_child\_samples': 82, 'learning\_rate': 0.020692228140216092, 'n\_estimators': 600, 'max\_depth': 9}. Best is trial 44 with value 0.07541413131040026.

[I 2025-11-03 12:33:28,656] Trial 58 finished with value: 0.07547013032916829 and parameters: {'lambda\_l1': 0.09859498197756293, 'lambda\_l2': 0.01810568173030358, 'num\_leaves': 193, 'feature\_fraction': 0.6063814273473093, 'bagging\_fraction': 0.7759468227286848, 'bagging\_freq': 3, 'min\_child\_samples': 84, 'learning\_rate': 0.020401303566534305, 'n\_estimators': 600, 'max\_depth': 8}. Best is trial 44 with value 0.07541413131040026.

[I 2025-11-03 12:33:58,442] Trial 59 finished with value: 0.07549905094661713 and parameters: {'lambda\_l1': 0.9944589272664739, 'lambda\_l2': 0.0025295918144031134, 'num\_leaves': 213, 'feature\_fraction': 0.5822874101288291, 'bagging\_fraction': 0.7946337609080157, 'bagging\_freq': 2, 'min\_child\_samples': 87, 'learning\_rate': 0.024756875087949284, 'n\_estimators': 500, 'max\_depth': 8}. Best is trial 44 with value 0.07541413131040026.

[I 2025-11-03 12:34:22,739] Trial 60 finished with value: 0.07550596343559034 and parameters: {'lambda\_l1': 0.1336049523892425, 'lambda\_l2': 0.0005119921718927385, 'num\_leaves': 221, 'feature\_fraction': 0.52469860723329, 'bagging\_fraction': 0.717342167888206, 'bagging\_freq': 1, 'min\_child\_samples': 92, 'learning\_rate': 0.029987402593924625, 'n\_estimators': 500, 'max\_depth': 9}. Best is trial 44 with value 0.07541413131040026.

[I 2025-11-03 12:35:03,388] Trial 61 finished with value: 0.07547487963906946 and parameters: {'lambda\_l1': 0.31731381700389205, 'lambda\_l2': 0.0016740069222594578, 'num\_leaves': 223, 'feature\_fraction': 0.5657410488057679, 'bagging\_fraction': 0.8915033075513841, 'bagging\_freq': 4, 'min\_child\_samples': 81, 'learning\_rate': 0.016112173639434138, 'n\_estimators': 600, 'max\_depth': 9}. Best is trial 44 with value 0.07541413131040026.

[I 2025-11-03 12:35:26,741] Trial 62 finished with value: 0.07551630175176663 and parameters: {'lambda\_l1': 0.042640371895050766, 'lambda\_l2': 0.005775471210111943, 'num\_leaves': 202, 'feature\_fraction': 0.6118374595073469, 'bagging\_fraction': 0.84692845404796, 'bagging\_freq': 4, 'min\_child\_samples': 85, 'learning\_rate': 0.020323878491098343, 'n\_estimators': 400, 'max\_depth': 8}. Best is trial 44 with value 0.07541413131040026.

[I 2025-11-03 12:35:58,507] Trial 63 finished with value: 0.07542481680151136 and parameters: {'lambda\_l1': 0.07121308108521368, 'lambda\_l2': 0.0027129904662135163, 'num\_leaves': 128, 'feature\_fraction': 0.640177184153021, 'bagging\_fraction': 0.8772675826961078, 'bagging\_freq': 5, 'min\_child\_samples': 71, 'learning\_rate': 0.024263384626137145, 'n\_estimators': 600, 'max\_depth': 10}. Best is trial 44 with value 0.07541413131040026.

[I 2025-11-03 12:36:30,631] Trial 64 finished with value: 0.07542506277492579 and parameters: {'lambda\_l1': 0.08905527725828731, 'lambda\_l2': 0.03679042682184002, 'num\_leaves': 127, 'feature\_fraction': 0.6454349703574093, 'bagging\_fraction':

0.7993091645981911, 'bagging\_freq': 5, 'min\_child\_samples': 71, 'learning\_rate': 0.024067233981951517, 'n\_estimators': 600, 'max\_depth': 9}. Best is trial 44 with value 0.07541413131040026.

[I 2025-11-03 12:36:43,113] Trial 65 finished with value: 0.07697333814540167 and parameters: {'lambda\_l1': 0.06551092855220497, 'lambda\_l2': 0.03125637558098239, 'num\_leaves': 127, 'feature\_fraction': 0.6996056322657868, 'bagging\_fraction': 0.8047280740157373, 'bagging\_freq': 5, 'min\_child\_samples': 71, 'learning\_rate': 0.02667098796153551, 'n\_estimators': 600, 'max\_depth': 3}. Best is trial 44 with value 0.07541413131040026.

[I 2025-11-03 12:37:00,488] Trial 66 finished with value: 0.07566833771956677 and parameters: {'lambda\_l1': 0.46952070323212747, 'lambda\_l2': 0.27959215674095506, 'num\_leaves': 112, 'feature\_fraction': 0.6209030957654255, 'bagging\_fraction': 0.7755728339710289, 'bagging\_freq': 5, 'min\_child\_samples': 76, 'learning\_rate': 0.05815885911096776, 'n\_estimators': 600, 'max\_depth': 5}. Best is trial 44 with value 0.07541413131040026.

[I 2025-11-03 12:37:22,286] Trial 67 finished with value: 0.07547056068683516 and parameters: {'lambda\_l1': 0.13011761502089195, 'lambda\_l2': 0.0024426689690027624, 'num\_leaves': 132, 'feature\_fraction': 0.6812617690388215, 'bagging\_fraction': 0.7572437490767415, 'bagging\_freq': 4, 'min\_child\_samples': 60, 'learning\_rate': 0.03840140950459516, 'n\_estimators': 500, 'max\_depth': 7}. Best is trial 44 with value 0.07541413131040026.

[I 2025-11-03 12:37:46,819] Trial 68 finished with value: 0.0757111527626244 and parameters: {'lambda\_l1': 0.017594256485778073, 'lambda\_l2': 0.05120188668651963, 'num\_leaves': 94, 'feature\_fraction': 0.5886556755846963, 'bagging\_fraction': 0.792863398958215, 'bagging\_freq': 5, 'min\_child\_samples': 79, 'learning\_rate': 0.013375082913416882, 'n\_estimators': 500, 'max\_depth': 10}. Best is trial 44 with value 0.07541413131040026.

[I 2025-11-03 12:38:22,435] Trial 69 finished with value: 0.07545319586636028 and parameters: {'lambda\_l1': 0.09609482653370319, 'lambda\_l2': 0.1506148460379285, 'num\_leaves': 147, 'feature\_fraction': 0.6544808764388255, 'bagging\_fraction': 0.8304531283361234, 'bagging\_freq': 3, 'min\_child\_samples': 74, 'learning\_rate': 0.024539175198599553, 'n\_estimators': 600, 'max\_depth': 11}. Best is trial 44 with value 0.07541413131040026.

[I 2025-11-03 12:38:47,323] Trial 70 finished with value: 0.07560408457706433 and parameters: {'lambda\_l1': 0.31846232590184814, 'lambda\_l2': 0.012440647461805536, 'num\_leaves': 57, 'feature\_fraction': 0.5309237686616037, 'bagging\_fraction': 0.6792224789550452, 'bagging\_freq': 5, 'min\_child\_samples': 69, 'learning\_rate': 0.031617411684550255, 'n\_estimators': 700, 'max\_depth': 9}. Best is trial 44 with value 0.07541413131040026.

[I 2025-11-03 12:39:21,482] Trial 71 finished with value: 0.07539999966546342 and parameters: {'lambda\_l1': 0.036235952321640626, 'lambda\_l2': 0.005770882855164118, 'num\_leaves': 139, 'feature\_fraction': 0.6436739673277394, 'bagging\_fraction': 0.8615329194314656, 'bagging\_freq': 5, 'min\_child\_samples': 88, 'learning\_rate': 0.020677073227175848, 'n\_estimators': 600, 'max\_depth': 9}. Best is trial 71 with value 0.07539999966546342.

[I 2025-11-03 12:39:55,630] Trial 72 finished with value: 0.07542871403363592 and parameters: {'lambda\_l1': 0.14337309711842255, 'lambda\_l2': 0.002979120722078609, 'num\_leaves': 141, 'feature\_fraction': 0.6416987202321512, 'bagging\_fraction': 0.8446916003200612, 'bagging\_freq': 5, 'min\_child\_samples': 88, 'learning\_rate': 0.02370076703043695, 'n\_estimators': 600, 'max\_depth': 9}. Best is trial 71 with value 0.07539999966546342.

[I 2025-11-03 12:40:24,290] Trial 73 finished with value: 0.07540383626960179 and parameters: {'lambda\_l1': 0.01259322177295738, 'lambda\_l2': 0.00835515041607851, 'num\_leaves': 141, 'feature\_fraction': 0.6390361792355875, 'bagging\_fraction': 0.8648880022865622, 'bagging\_freq': 5, 'min\_child\_samples': 89, 'learning\_rate': 0.02439654046158553, 'n\_estimators': 500, 'max\_depth': 10}. Best is trial 71 with value 0.07539999966546342.

[I 2025-11-03 12:40:48,159] Trial 74 finished with value: 0.07551355860293901 and parameters: {'lambda\_l1': 0.01202882167884987, 'lambda\_l2': 0.006523918113087766, 'num\_leaves': 172, 'feature\_fraction': 0.7323632070558714, 'bagging\_fraction':



0.8652763927521008, 'bagging\_freq': 5, 'min\_child\_samples': 88, 'learning\_rate': 0.03547430296035581, 'n\_estimators': 400, 'max\_depth': 10}. Best is trial 71 with value: 0.07539999966546342.

[I 2025-11-03 12:41:11,116] Trial 75 finished with value: 0.07563220104545576 and parameters: {'lambda\_l1': 0.026707708489538722, 'lambda\_l2': 0.008717068578959788, 'num\_leaves': 135, 'feature\_fraction': 0.6225131939138902, 'bagging\_fraction': 0.8792273462144771, 'bagging\_freq': 5, 'min\_child\_samples': 94, 'learning\_rate': 0.014378887932352265, 'n\_estimators': 400, 'max\_depth': 10}. Best is trial 71 with value: 0.07539999966546342.

[I 2025-11-03 12:41:39,583] Trial 76 finished with value: 0.07548102128198961 and parameters: {'lambda\_l1': 0.07454958499306141, 'lambda\_l2': 0.02700779310958887, 'num\_leaves': 152, 'feature\_fraction': 0.6667185370224842, 'bagging\_fraction': 0.7379414560114664, 'bagging\_freq': 5, 'min\_child\_samples': 97, 'learning\_rate': 0.028829128731357276, 'n\_estimators': 500, 'max\_depth': 11}. Best is trial 71 with value: 0.07539999966546342.

[I 2025-11-03 12:42:30,838] Trial 77 finished with value: 0.07543408485206422 and parameters: {'lambda\_l1': 0.054389905701138545, 'lambda\_l2': 0.000973006174640788, 'num\_leaves': 114, 'feature\_fraction': 0.6939857778035031, 'bagging\_fraction': 0.8185180172048306, 'bagging\_freq': 4, 'min\_child\_samples': 74, 'learning\_rate': 0.016842404799589875, 'n\_estimators': 1000, 'max\_depth': 10}. Best is trial 71 with value: 0.07539999966546342.

[I 2025-11-03 12:43:10,240] Trial 78 finished with value: 0.07544731271845782 and parameters: {'lambda\_l1': 0.01177682601650272, 'lambda\_l2': 0.01552449699991437, 'num\_leaves': 164, 'feature\_fraction': 0.8195299553684084, 'bagging\_fraction': 0.838790558107153, 'bagging\_freq': 5, 'min\_child\_samples': 71, 'learning\_rate': 0.012196272631698233, 'n\_estimators': 700, 'max\_depth': 8}. Best is trial 71 with value: 0.07539999966546342.

[I 2025-11-03 12:43:37,031] Trial 79 finished with value: 0.07550246972189532 and parameters: {'lambda\_l1': 0.03409383661616758, 'lambda\_l2': 0.004357870910220086, 'num\_leaves': 127, 'feature\_fraction': 0.600116386924829, 'bagging\_fraction': 0.8530539082007328, 'bagging\_freq': 5, 'min\_child\_samples': 67, 'learning\_rate': 0.01906123868043914, 'n\_estimators': 500, 'max\_depth': 11}. Best is trial 71 with value: 0.07539999966546342.

[I 2025-11-03 12:44:15,469] Trial 80 finished with value: 0.07546837695328 and parameters: {'lambda\_l1': 4.473387615319269e-05, 'lambda\_l2': 0.09441499199318049, 'num\_leaves': 140, 'feature\_fraction': 0.6430901938777246, 'bagging\_fraction': 0.9801861450791077, 'bagging\_freq': 6, 'min\_child\_samples': 78, 'learning\_rate': 0.026137213789962848, 'n\_estimators': 900, 'max\_depth': 9}. Best is trial 71 with value: 0.07539999966546342.

[I 2025-11-03 12:44:49,554] Trial 81 finished with value: 0.07545845114255034 and parameters: {'lambda\_l1': 0.1611285143986818, 'lambda\_l2': 0.0038681506163879076, 'num\_leaves': 140, 'feature\_fraction': 0.6386188047280146, 'bagging\_fraction': 0.8868158146603206, 'bagging\_freq': 5, 'min\_child\_samples': 89, 'learning\_rate': 0.023133441166293955, 'n\_estimators': 600, 'max\_depth': 9}. Best is trial 71 with value: 0.07539999966546342.

[I 2025-11-03 12:45:30,410] Trial 82 finished with value: 0.07540082078122844 and parameters: {'lambda\_l1': 0.23170025490692547, 'lambda\_l2': 0.0029897192180929587, 'num\_leaves': 151, 'feature\_fraction': 0.6778808561215048, 'bagging\_fraction': 0.8597470359565883, 'bagging\_freq': 5, 'min\_child\_samples': 93, 'learning\_rate': 0.02346316932575789, 'n\_estimators': 700, 'max\_depth': 9}. Best is trial 71 with value: 0.07539999966546342.

[I 2025-11-03 12:46:13,736] Trial 83 finished with value: 0.07540702640330252 and parameters: {'lambda\_l1': 0.24918846376048728, 'lambda\_l2': 0.01036827776452264, 'num\_leaves': 153, 'feature\_fraction': 0.6745557326721848, 'bagging\_fraction': 0.8658089887210181, 'bagging\_freq': 5, 'min\_child\_samples': 100, 'learning\_rate': 0.01509071995889224, 'n\_estimators': 700, 'max\_depth': 10}. Best is trial 71 with value: 0.07539999966546342.

[I 2025-11-03 12:46:56,652] Trial 84 finished with value: 0.0754077403016058 and parameters: {'lambda\_l1': 0.28598977039133905, 'lambda\_l2': 0.010152390573524349, 'num\_leaves': 152, 'feature\_fraction': 0.6750412340861682, 'bagging\_fraction': 0.8624530678303372, 'bagging\_freq': 5, 'min\_child\_samples': 92, 'learning\_rate': 0.01509071995889224, 'n\_estimators': 700, 'max\_depth': 10}. Best is trial 71 with value: 0.07539999966546342.

0.014598829733111666, 'n\_estimators': 700, 'max\_depth': 10}. Best is trial 71 with value 0.07539999966546342.

[I 2025-11-03 12:47:47,631] Trial 85 finished with value: 0.07542625531560261 and parameters: {'lambda\_l1': 0.44702882316364856, 'lambda\_l2': 0.01091550339238885, 'num\_leaves': 161, 'feature\_fraction': 0.710512425903322, 'bagging\_fraction': 0.8647127489185688, 'bagging\_freq': 5, 'min\_child\_samples': 99, 'learning\_rate': 0.01022428907513469, 'n\_estimators': 800, 'max\_depth': 10}. Best is trial 71 with value 0.07539999966546342.

[I 2025-11-03 12:48:34,541] Trial 86 finished with value: 0.07540733783761151 and parameters: {'lambda\_l1': 0.3442257032944853, 'lambda\_l2': 0.008095434756037037, 'num\_leaves': 181, 'feature\_fraction': 0.6802313119804203, 'bagging\_fraction': 0.8947897983318064, 'bagging\_freq': 4, 'min\_child\_samples': 93, 'learning\_rate': 0.014580136681393385, 'n\_estimators': 700, 'max\_depth': 10}. Best is trial 71 with value 0.07539999966546342.

[I 2025-11-03 12:49:21,850] Trial 87 finished with value: 0.07541010150442112 and parameters: {'lambda\_l1': 0.9595163444222062, 'lambda\_l2': 0.00769764359605164, 'num\_leaves': 181, 'feature\_fraction': 0.67911888314736, 'bagging\_fraction': 0.9043044632846331, 'bagging\_freq': 4, 'min\_child\_samples': 94, 'learning\_rate': 0.014549399364731722, 'n\_estimators': 700, 'max\_depth': 11}. Best is trial 71 with value 0.07539999966546342.

[I 2025-11-03 12:50:07,842] Trial 88 finished with value: 0.07541103525020927 and parameters: {'lambda\_l1': 0.8155426506190923, 'lambda\_l2': 0.008363880235015114, 'num\_leaves': 177, 'feature\_fraction': 0.7483664926125608, 'bagging\_fraction': 0.895180842203547, 'bagging\_freq': 4, 'min\_child\_samples': 94, 'learning\_rate': 0.014533827586686884, 'n\_estimators': 700, 'max\_depth': 12}. Best is trial 71 with value 0.07539999966546342.

[I 2025-11-03 12:50:53,877] Trial 89 finished with value: 0.07542165188995054 and parameters: {'lambda\_l1': 0.9757083706843747, 'lambda\_l2': 0.017466032384458884, 'num\_leaves': 173, 'feature\_fraction': 0.6714273889579986, 'bagging\_fraction': 0.9016675977047349, 'bagging\_freq': 4, 'min\_child\_samples': 94, 'learning\_rate': 0.014526057191730547, 'n\_estimators': 700, 'max\_depth': 12}. Best is trial 71 with value 0.07539999966546342.

[I 2025-11-03 12:51:47,332] Trial 90 finished with value: 0.07542092483776652 and parameters: {'lambda\_l1': 0.6201151568116137, 'lambda\_l2': 0.008732259001979154, 'num\_leaves': 180, 'feature\_fraction': 0.7511789272980063, 'bagging\_fraction': 0.9292264443320155, 'bagging\_freq': 4, 'min\_child\_samples': 96, 'learning\_rate': 0.012208091522627279, 'n\_estimators': 800, 'max\_depth': 12}. Best is trial 71 with value 0.07539999966546342.

[I 2025-11-03 12:52:35,582] Trial 91 finished with value: 0.07540299921177496 and parameters: {'lambda\_l1': 0.24557080492183797, 'lambda\_l2': 0.021830622579315687, 'num\_leaves': 186, 'feature\_fraction': 0.6853409175143695, 'bagging\_fraction': 0.898764995531535, 'bagging\_freq': 3, 'min\_child\_samples': 92, 'learning\_rate': 0.015898751003024597, 'n\_estimators': 700, 'max\_depth': 11}. Best is trial 71 with value 0.07539999966546342.

[I 2025-11-03 12:53:22,529] Trial 92 finished with value: 0.07541011799980708 and parameters: {'lambda\_l1': 0.7055517324034712, 'lambda\_l2': 0.024888559702941244, 'num\_leaves': 186, 'feature\_fraction': 0.7272432110235643, 'bagging\_fraction': 0.8932342239750086, 'bagging\_freq': 4, 'min\_child\_samples': 92, 'learning\_rate': 0.015319407524587521, 'n\_estimators': 700, 'max\_depth': 11}. Best is trial 71 with value 0.07539999966546342.

[I 2025-11-03 12:54:09,753] Trial 93 finished with value: 0.07541342675825509 and parameters: {'lambda\_l1': 0.7209291809983825, 'lambda\_l2': 0.02378746303171199, 'num\_leaves': 191, 'feature\_fraction': 0.7266899584471542, 'bagging\_fraction': 0.8961423128017402, 'bagging\_freq': 4, 'min\_child\_samples': 92, 'learning\_rate': 0.015317743340321337, 'n\_estimators': 700, 'max\_depth': 12}. Best is trial 71 with value 0.07539999966546342.

[I 2025-11-03 12:54:59,326] Trial 94 finished with value: 0.07544954868882506 and parameters: {'lambda\_l1': 0.2728715128840146, 'lambda\_l2': 0.013234289504945453, 'num\_leaves': 187, 'feature\_fraction': 0.6824794640845994, 'bagging\_fraction': 0.9062682348394626, 'bagging\_freq': 3, 'min\_child\_samples': 98, 'learning\_rate':

0.01008560344474906, 'n\_estimators': 700, 'max\_depth': 11}. Best is trial 71 with value 0.07539999966546342.

[I 2025-11-03 12:55:47,220] Trial 95 finished with value: 0.07543901842425071 and parameters: {'lambda\_l1': 0.25212999245737905, 'lambda\_l2': 0.008153205867486175, 'num\_leaves': 176, 'feature\_fraction': 0.7511857804723004, 'bagging\_fraction': 0.9206275278506637, 'bagging\_freq': 3, 'min\_child\_samples': 95, 'learning\_rate': 0.013414226154626448, 'n\_estimators': 700, 'max\_depth': 11}. Best is trial 71 with value 0.07539999966546342.

[I 2025-11-03 12:56:30,071] Trial 96 finished with value: 0.07545016572859797 and parameters: {'lambda\_l1': 0.7195497043768951, 'lambda\_l2': 0.021208901431388465, 'num\_leaves': 155, 'feature\_fraction': 0.7719965918835738, 'bagging\_fraction': 0.8609647924491137, 'bagging\_freq': 4, 'min\_child\_samples': 91, 'learning\_rate': 0.018881355984189028, 'n\_estimators': 700, 'max\_depth': 11}. Best is trial 71 with value 0.07539999966546342.

[I 2025-11-03 12:57:14,724] Trial 97 finished with value: 0.07543905162395219 and parameters: {'lambda\_l1': 0.38373791378020783, 'lambda\_l2': 0.053557956559950964, 'num\_leaves': 167, 'feature\_fraction': 0.7203399685895888, 'bagging\_fraction': 0.9386047020514241, 'bagging\_freq': 4, 'min\_child\_samples': 93, 'learning\_rate': 0.014160177190052425, 'n\_estimators': 700, 'max\_depth': 12}. Best is trial 71 with value 0.07539999966546342.

[I 2025-11-03 12:58:11,443] Trial 98 finished with value: 0.07550523555591643 and parameters: {'lambda\_l1': 0.7307072967043741, 'lambda\_l2': 0.005152306133252968, 'num\_leaves': 186, 'feature\_fraction': 0.737423228279995, 'bagging\_fraction': 0.9139299382870547, 'bagging\_freq': 3, 'min\_child\_samples': 97, 'learning\_rate': 0.008082845483703914, 'n\_estimators': 800, 'max\_depth': 11}. Best is trial 71 with value 0.07539999966546342.

[I 2025-11-03 12:58:55,314] Trial 99 finished with value: 0.07541053848215255 and parameters: {'lambda\_l1': 0.5044182995213483, 'lambda\_l2': 0.01161124294785137, 'num\_leaves': 154, 'feature\_fraction': 0.6883163585750262, 'bagging\_fraction': 0.8896571888883418, 'bagging\_freq': 4, 'min\_child\_samples': 100, 'learning\_rate': 0.015380915591723556, 'n\_estimators': 700, 'max\_depth': 11}. Best is trial 71 with value 0.07539999966546342.

[I 2025-11-03 12:59:39,593] Trial 100 finished with value: 0.07542720929823482 and parameters: {'lambda\_l1': 0.5552903555976992, 'lambda\_l2': 0.011408112762265978, 'num\_leaves': 150, 'feature\_fraction': 0.6855786630235766, 'bagging\_fraction': 0.8706480848278222, 'bagging\_freq': 3, 'min\_child\_samples': 100, 'learning\_rate': 0.015964114927535404, 'n\_estimators': 700, 'max\_depth': 11}. Best is trial 71 with value 0.07539999966546342.

[I 2025-11-03 13:00:23,661] Trial 101 finished with value: 0.07543122536116395 and parameters: {'lambda\_l1': 0.38629167267271364, 'lambda\_l2': 0.006531760520546965, 'num\_leaves': 168, 'feature\_fraction': 0.6595808219904145, 'bagging\_fraction': 0.8894432257815928, 'bagging\_freq': 4, 'min\_child\_samples': 90, 'learning\_rate': 0.017669106842231164, 'n\_estimators': 700, 'max\_depth': 12}. Best is trial 71 with value 0.07539999966546342.

[I 2025-11-03 13:01:08,577] Trial 102 finished with value: 0.07544251559456994 and parameters: {'lambda\_l1': 0.25027695864048594, 'lambda\_l2': 0.007261913758531762, 'num\_leaves': 160, 'feature\_fraction': 0.7080922312549532, 'bagging\_fraction': 0.8533029342761786, 'bagging\_freq': 4, 'min\_child\_samples': 86, 'learning\_rate': 0.011515024240373197, 'n\_estimators': 700, 'max\_depth': 10}. Best is trial 71 with value 0.07539999966546342.

[I 2025-11-03 13:01:55,793] Trial 103 finished with value: 0.0753991219410719 and parameters: {'lambda\_l1': 0.1778064350661178, 'lambda\_l2': 0.01612061045657271, 'num\_leaves': 180, 'feature\_fraction': 0.7413045324696533, 'bagging\_fraction': 0.8979997662022667, 'bagging\_freq': 4, 'min\_child\_samples': 98, 'learning\_rate': 0.015576734016841232, 'n\_estimators': 700, 'max\_depth': 11}. Best is trial 103 with value 0.0753991219410719.

[I 2025-11-03 13:02:50,656] Trial 104 finished with value: 0.07542240889380698 and parameters: {'lambda\_l1': 0.18518486239231838, 'lambda\_l2': 0.015724106614855925, 'num\_leaves': 196, 'feature\_fraction': 0.6766475636713847, 'bagging\_fraction': 0.95188356543855, 'bagging\_freq': 4, 'min\_child\_samples': 98, 'learning\_rate':

0.018895629594557733, 'n\_estimators': 800, 'max\_depth': 11}. Best is trial 103 with value: 0.0753991219410719.

[I 2025-11-03 13:03:33,695] Trial 105 finished with value: 0.07545675061989174 and parameters: {'lambda\_l1': 0.34124122877983487, 'lambda\_l2': 0.04041438560340072, 'num\_leaves': 155, 'feature\_fraction': 0.713783025867258, 'bagging\_fraction': 0.9101873481883079, 'bagging\_freq': 4, 'min\_child\_samples': 91, 'learning\_rate': 0.020086778941553852, 'n\_estimators': 700, 'max\_depth': 11}. Best is trial 103 with value: 0.0753991219410719.

[I 2025-11-03 13:04:24,769] Trial 106 finished with value: 0.0754235379096075 and parameters: {'lambda\_l1': 0.2121732011760636, 'lambda\_l2': 0.03256567053159843, 'num\_leaves': 183, 'feature\_fraction': 0.6909276903451946, 'bagging\_fraction': 0.9311854646029117, 'bagging\_freq': 2, 'min\_child\_samples': 96, 'learning\_rate': 0.016062679622837066, 'n\_estimators': 700, 'max\_depth': 10}. Best is trial 103 with value: 0.0753991219410719.

[I 2025-11-03 13:05:08,092] Trial 107 finished with value: 0.07542003171750801 and parameters: {'lambda\_l1': 0.4773892481414, 'lambda\_l2': 0.020185198957712897, 'num\_leaves': 140, 'feature\_fraction': 0.6711393081676774, 'bagging\_fraction': 0.8841334895383167, 'bagging\_freq': 4, 'min\_child\_samples': 100, 'learning\_rate': 0.013412746444809182, 'n\_estimators': 700, 'max\_depth': 11}. Best is trial 103 with value: 0.0753991219410719.

[I 2025-11-03 13:06:00,609] Trial 108 finished with value: 0.0754373201613009 and parameters: {'lambda\_l1': 0.5574203669009005, 'lambda\_l2': 0.027316270470694754, 'num\_leaves': 171, 'feature\_fraction': 0.7020646905012525, 'bagging\_fraction': 0.8685327815086782, 'bagging\_freq': 3, 'min\_child\_samples': 89, 'learning\_rate': 0.02211473486596959, 'n\_estimators': 800, 'max\_depth': 10}. Best is trial 103 with value: 0.0753991219410719.

[I 2025-11-03 13:06:49,171] Trial 109 finished with value: 0.07544583831703226 and parameters: {'lambda\_l1': 0.2799065316770679, 'lambda\_l2': 0.012874318229004821, 'num\_leaves': 190, 'feature\_fraction': 0.6624379677858365, 'bagging\_fraction': 0.8347356658337988, 'bagging\_freq': 4, 'min\_child\_samples': 96, 'learning\_rate': 0.010585567488586507, 'n\_estimators': 700, 'max\_depth': 11}. Best is trial 103 with value: 0.0753991219410719.

[I 2025-11-03 13:07:30,050] Trial 110 finished with value: 0.0755491233369113 and parameters: {'lambda\_l1': 0.3969483976257797, 'lambda\_l2': 0.07238586871542314, 'num\_leaves': 150, 'feature\_fraction': 0.6513300866683696, 'bagging\_fraction': 0.6075292193849369, 'bagging\_freq': 5, 'min\_child\_samples': 92, 'learning\_rate': 0.009566791446231997, 'n\_estimators': 700, 'max\_depth': 10}. Best is trial 103 with value: 0.0753991219410719.

[I 2025-11-03 13:08:16,944] Trial 111 finished with value: 0.07542588515596163 and parameters: {'lambda\_l1': 0.8507668713200046, 'lambda\_l2': 0.010009331049738583, 'num\_leaves': 176, 'feature\_fraction': 0.7717382063082463, 'bagging\_fraction': 0.8923059399584317, 'bagging\_freq': 4, 'min\_child\_samples': 94, 'learning\_rate': 0.015364293599760407, 'n\_estimators': 700, 'max\_depth': 11}. Best is trial 103 with value: 0.0753991219410719.

[I 2025-11-03 13:08:59,793] Trial 112 finished with value: 0.07542487581538934 and parameters: {'lambda\_l1': 0.6353510547500579, 'lambda\_l2': 0.005169850684160139, 'num\_leaves': 162, 'feature\_fraction': 0.7418916435368412, 'bagging\_fraction': 0.6552250398702271, 'bagging\_freq': 4, 'min\_child\_samples': 93, 'learning\_rate': 0.01718100266488443, 'n\_estimators': 700, 'max\_depth': 12}. Best is trial 103 with value: 0.0753991219410719.

[I 2025-11-03 13:09:44,459] Trial 113 finished with value: 0.07543906062576047 and parameters: {'lambda\_l1': 0.2210829149590214, 'lambda\_l2': 0.008893368778746885, 'num\_leaves': 181, 'feature\_fraction': 0.758656434916381, 'bagging\_fraction': 0.5534770277890306, 'bagging\_freq': 4, 'min\_child\_samples': 95, 'learning\_rate': 0.013791223528973771, 'n\_estimators': 700, 'max\_depth': 12}. Best is trial 103 with value: 0.0753991219410719.

[I 2025-11-03 13:10:32,445] Trial 114 finished with value: 0.07792138641903136 and parameters: {'lambda\_l1': 0.8396092089562054, 'lambda\_l2': 0.007006354931642176, 'num\_leaves': 177, 'feature\_fraction': 0.7191100806542573, 'bagging\_fraction': 0.8993582133812725, 'bagging\_freq': 5, 'min\_child\_samples': 87, 'learning\_rate': 0.12928329262195368, 'n\_estimators': 800, 'max\_depth': 10}. Best is trial 103 with value: 0.0753991219410719.



0.0753991219410719.  
[I 2025-11-03 13:10:52,602] Trial 115 finished with value: 0.07595814703365235 and parameters: {'lambda\_l1': 0.15709661235833808, 'lambda\_l2': 0.003348861799853813, 'num\_leaves': 196, 'feature\_fraction': 0.8007890368221012, 'bagging\_fraction': 0.8560600493604046, 'bagging\_freq': 4, 'min\_child\_samples': 98, 'learning\_rate': 0.01212525738670196, 'n\_estimators': 300, 'max\_depth': 11}. Best is trial 103 with value 0.0753991219410719.  
[I 2025-11-03 13:11:37,295] Trial 116 finished with value: 0.07541782916271955 and parameters: {'lambda\_l1': 0.3276948294326267, 'lambda\_l2': 0.01560042284259583, 'num\_leaves': 156, 'feature\_fraction': 0.6890435895413014, 'bagging\_fraction': 0.9230985183157465, 'bagging\_freq': 4, 'min\_child\_samples': 89, 'learning\_rate': 0.01452198259998892, 'n\_estimators': 700, 'max\_depth': 10}. Best is trial 103 with value 0.0753991219410719.  
[I 2025-11-03 13:12:23,207] Trial 117 finished with value: 0.0754439996049036 and parameters: {'lambda\_l1': 0.5322114374437928, 'lambda\_l2': 0.011810217988455853, 'num\_leaves': 170, 'feature\_fraction': 0.6996368757128308, 'bagging\_fraction': 0.8766858170395971, 'bagging\_freq': 4, 'min\_child\_samples': 100, 'learning\_rate': 0.01775761462566797, 'n\_estimators': 700, 'max\_depth': 11}. Best is trial 103 with value 0.0753991219410719.  
[I 2025-11-03 13:13:05,072] Trial 118 finished with value: 0.07542854086599364 and parameters: {'lambda\_l1': 0.11409879926079038, 'lambda\_l2': 0.02007653601183714, 'num\_leaves': 147, 'feature\_fraction': 0.7860851076783069, 'bagging\_fraction': 0.89670347286895, 'bagging\_freq': 5, 'min\_child\_samples': 84, 'learning\_rate': 0.012654187698195115, 'n\_estimators': 700, 'max\_depth': 12}. Best is trial 103 with value 0.0753991219410719.  
[I 2025-11-03 13:13:44,716] Trial 119 finished with value: 0.07544574530124229 and parameters: {'lambda\_l1': 0.17895412193459903, 'lambda\_l2': 0.004899480807887583, 'num\_leaves': 189, 'feature\_fraction': 0.6748016769879174, 'bagging\_fraction': 0.9075658875761103, 'bagging\_freq': 5, 'min\_child\_samples': 90, 'learning\_rate': 0.021752332872646857, 'n\_estimators': 600, 'max\_depth': 11}. Best is trial 103 with value 0.0753991219410719.  
[I 2025-11-03 13:14:31,430] Trial 120 finished with value: 0.07543534473347328 and parameters: {'lambda\_l1': 0.9805765880248151, 'lambda\_l2': 0.041438919439223926, 'num\_leaves': 133, 'feature\_fraction': 0.7305300284781806, 'bagging\_fraction': 0.8687268316385515, 'bagging\_freq': 5, 'min\_child\_samples': 98, 'learning\_rate': 0.015432408383082305, 'n\_estimators': 800, 'max\_depth': 10}. Best is trial 103 with value 0.0753991219410719.  
[I 2025-11-03 13:15:20,058] Trial 121 finished with value: 0.07541527753760704 and parameters: {'lambda\_l1': 0.7321346810546757, 'lambda\_l2': 0.009408935147372385, 'num\_leaves': 200, 'feature\_fraction': 0.7289044021295864, 'bagging\_fraction': 0.8963408985949403, 'bagging\_freq': 4, 'min\_child\_samples': 92, 'learning\_rate': 0.015170303534180671, 'n\_estimators': 700, 'max\_depth': 12}. Best is trial 103 with value 0.0753991219410719.  
[I 2025-11-03 13:16:06,931] Trial 122 finished with value: 0.07542336106020331 and parameters: {'lambda\_l1': 0.45617651129657993, 'lambda\_l2': 0.025367271276541654, 'num\_leaves': 191, 'feature\_fraction': 0.7212868844899457, 'bagging\_fraction': 0.8843941797994636, 'bagging\_freq': 4, 'min\_child\_samples': 93, 'learning\_rate': 0.01672480934279047, 'n\_estimators': 700, 'max\_depth': 12}. Best is trial 103 with value 0.0753991219410719.  
[I 2025-11-03 13:16:57,560] Trial 123 finished with value: 0.07543365819348484 and parameters: {'lambda\_l1': 0.6389025335110874, 'lambda\_l2': 0.023443790289823838, 'num\_leaves': 210, 'feature\_fraction': 0.7452611212951835, 'bagging\_fraction': 0.9151810601669413, 'bagging\_freq': 4, 'min\_child\_samples': 95, 'learning\_rate': 0.011761587531238798, 'n\_estimators': 700, 'max\_depth': 12}. Best is trial 103 with value 0.0753991219410719.  
[I 2025-11-03 13:17:42,521] Trial 124 finished with value: 0.0754507907917183 and parameters: {'lambda\_l1': 0.3758124257766054, 'lambda\_l2': 0.016114403616086247, 'num\_leaves': 183, 'feature\_fraction': 0.960888652517556, 'bagging\_fraction': 0.8458426580684841, 'bagging\_freq': 4, 'min\_child\_samples': 91, 'learning\_rate': 0.019496877505432306, 'n\_estimators': 700, 'max\_depth': 12}. Best is trial 103 with value 0.0753991219410719.

0.0753991219410719.

[I 2025-11-03 13:18:06,566] Trial 125 finished with value: 0.07569246724796394 and parameters: {'lambda\_l1': 0.2909153370931745, 'lambda\_l2': 0.00730686918864357, 'num\_leaves': 165, 'feature\_fraction': 0.7599117631404088, 'bagging\_fraction': 0.9018171421030878, 'bagging\_freq': 4, 'min\_child\_samples': 87, 'learning\_rate': 0.014873183037941017, 'n\_estimators': 600, 'max\_depth': 6}. Best is trial 103 with value 0.0753991219410719.

[I 2025-11-03 13:18:55,047] Trial 126 finished with value: 0.07544142179787529 and parameters: {'lambda\_l1': 0.5231505029519975, 'lambda\_l2': 0.013912419111171855, 'num\_leaves': 179, 'feature\_fraction': 0.7076207985748246, 'bagging\_fraction': 0.8834170832832607, 'bagging\_freq': 3, 'min\_child\_samples': 96, 'learning\_rate': 0.013223007795216676, 'n\_estimators': 700, 'max\_depth': 11}. Best is trial 103 with value 0.0753991219410719.

[I 2025-11-03 13:19:35,438] Trial 127 finished with value: 0.07541514786347064 and parameters: {'lambda\_l1': 0.7700905153235799, 'lambda\_l2': 0.0060926801528974174, 'num\_leaves': 194, 'feature\_fraction': 0.6626749214869316, 'bagging\_fraction': 0.8224118827971745, 'bagging\_freq': 5, 'min\_child\_samples': 93, 'learning\_rate': 0.01641504671833489, 'n\_estimators': 600, 'max\_depth': 11}. Best is trial 103 with value 0.0753991219410719.

[I 2025-11-03 13:20:23,918] Trial 128 finished with value: 0.07541257105273812 and parameters: {'lambda\_l1': 0.22068502392006012, 'lambda\_l2': 0.010946701868151273, 'num\_leaves': 138, 'feature\_fraction': 0.6952154795128237, 'bagging\_fraction': 0.8581883495775633, 'bagging\_freq': 4, 'min\_child\_samples': 97, 'learning\_rate': 0.011038358942492431, 'n\_estimators': 800, 'max\_depth': 10}. Best is trial 103 with value 0.0753991219410719.

[I 2025-11-03 13:21:11,438] Trial 129 finished with value: 0.07542475530237053 and parameters: {'lambda\_l1': 0.2307406673398789, 'lambda\_l2': 0.010428712972315126, 'num\_leaves': 138, 'feature\_fraction': 0.6935257408613567, 'bagging\_fraction': 0.8570418603371959, 'bagging\_freq': 5, 'min\_child\_samples': 98, 'learning\_rate': 0.010965465398617936, 'n\_estimators': 800, 'max\_depth': 10}. Best is trial 103 with value 0.0753991219410719.

[I 2025-11-03 13:21:54,697] Trial 130 finished with value: 0.07538118899749845 and parameters: {'lambda\_l1': 0.11245392538961946, 'lambda\_l2': 0.0035004125545440475, 'num\_leaves': 117, 'feature\_fraction': 0.6811929713430782, 'bagging\_fraction': 0.8360385865874116, 'bagging\_freq': 4, 'min\_child\_samples': 100, 'learning\_rate': 0.018256386451821698, 'n\_estimators': 800, 'max\_depth': 10}. Best is trial 130 with value 0.07538118899749845.

[I 2025-11-03 13:22:43,784] Trial 131 finished with value: 0.07543698164719588 and parameters: {'lambda\_l1': 0.14322123542312726, 'lambda\_l2': 0.003241675730185161, 'num\_leaves': 121, 'feature\_fraction': 0.6532242879355245, 'bagging\_fraction': 0.839313807140194, 'bagging\_freq': 4, 'min\_child\_samples': 100, 'learning\_rate': 0.018255302540341932, 'n\_estimators': 900, 'max\_depth': 10}. Best is trial 130 with value 0.07538118899749845.

[I 2025-11-03 13:23:32,069] Trial 132 finished with value: 0.07540914400446767 and parameters: {'lambda\_l1': 0.11759535817135884, 'lambda\_l2': 0.00832109462539108, 'num\_leaves': 144, 'feature\_fraction': 0.6742182153121101, 'bagging\_fraction': 0.8695108010035948, 'bagging\_freq': 3, 'min\_child\_samples': 97, 'learning\_rate': 0.02065787439798395, 'n\_estimators': 800, 'max\_depth': 10}. Best is trial 130 with value 0.07538118899749845.

[I 2025-11-03 13:24:20,815] Trial 133 finished with value: 0.07542332110481126 and parameters: {'lambda\_l1': 0.29847519986472776, 'lambda\_l2': 0.004143470791089187, 'num\_leaves': 145, 'feature\_fraction': 0.6805286372289969, 'bagging\_fraction': 0.8787963352038675, 'bagging\_freq': 3, 'min\_child\_samples': 95, 'learning\_rate': 0.0207290164513417, 'n\_estimators': 800, 'max\_depth': 10}. Best is trial 130 with value 0.07538118899749845.

[I 2025-11-03 13:25:11,046] Trial 134 finished with value: 0.07542114086173779 and parameters: {'lambda\_l1': 0.4432949282066286, 'lambda\_l2': 0.007623906682059026, 'num\_leaves': 158, 'feature\_fraction': 0.6680842687256531, 'bagging\_fraction': 0.8687664071394929, 'bagging\_freq': 3, 'min\_child\_samples': 98, 'learning\_rate': 0.022124284037653565, 'n\_estimators': 800, 'max\_depth': 10}. Best is trial 130 with value 0.07538118899749845.

0.07538118899749845.  
[I 2025-11-03 13:25:37,248] Trial 135 finished with value: 0.0760464033754535 and parameters: {'lambda\_l1': 0.015642331406490573, 'lambda\_l2': 0.00490097744737215, 'num\_leaves': 16, 'feature\_fraction': 0.628059163636321, 'bagging\_fraction': 0.8464639083882988, 'bagging\_freq': 3, 'min\_child\_samples': 94, 'learning\_rate': 0.019481686101488694, 'n\_estimators': 900, 'max\_depth': 10}. Best is trial 130 with value 0.07538118899749845.  
[I 2025-11-03 13:26:26,767] Trial 136 finished with value: 0.07542383761269092 and parameters: {'lambda\_l1': 0.09764371061703857, 'lambda\_l2': 0.008553969109935153, 'num\_leaves': 149, 'feature\_fraction': 0.6726661321297619, 'bagging\_fraction': 0.8899461055423913, 'bagging\_freq': 3, 'min\_child\_samples': 96, 'learning\_rate': 0.01776656681625202, 'n\_estimators': 800, 'max\_depth': 11}. Best is trial 130 with value 0.07538118899749845.  
[I 2025-11-03 13:27:05,725] Trial 137 finished with value: 0.07543593387640188 and parameters: {'lambda\_l1': 0.184907881375715, 'lambda\_l2': 0.005817777425152124, 'num\_leaves': 106, 'feature\_fraction': 0.6855527911097937, 'bagging\_fraction': 0.8724689700065434, 'bagging\_freq': 3, 'min\_child\_samples': 90, 'learning\_rate': 0.014425902975057253, 'n\_estimators': 700, 'max\_depth': 10}. Best is trial 130 with value 0.07538118899749845.  
[I 2025-11-03 13:27:50,749] Trial 138 finished with value: 0.07541024359464243 and parameters: {'lambda\_l1': 0.14250714567893977, 'lambda\_l2': 0.017162162652606987, 'num\_leaves': 131, 'feature\_fraction': 0.649489084329237, 'bagging\_fraction': 0.9290139069445408, 'bagging\_freq': 2, 'min\_child\_samples': 100, 'learning\_rate': 0.016527253374378433, 'n\_estimators': 700, 'max\_depth': 10}. Best is trial 130 with value 0.07538118899749845.  
[I 2025-11-03 13:28:39,035] Trial 139 finished with value: 0.07544992557700507 and parameters: {'lambda\_l1': 0.10838747985491191, 'lambda\_l2': 0.0017846383357142904, 'num\_leaves': 129, 'feature\_fraction': 0.6479481465377489, 'bagging\_fraction': 0.9282028237050568, 'bagging\_freq': 2, 'min\_child\_samples': 100, 'learning\_rate': 0.026242948610190796, 'n\_estimators': 800, 'max\_depth': 9}. Best is trial 130 with value 0.07538118899749845.  
[I 2025-11-03 13:29:18,307] Trial 140 finished with value: 0.07542636231105221 and parameters: {'lambda\_l1': 0.13187037066960283, 'lambda\_l2': 0.01794064414054096, 'num\_leaves': 144, 'feature\_fraction': 0.6587020872478653, 'bagging\_fraction': 0.9113123006288627, 'bagging\_freq': 2, 'min\_child\_samples': 98, 'learning\_rate': 0.016923786441685715, 'n\_estimators': 600, 'max\_depth': 11}. Best is trial 130 with value 0.07538118899749845.  
[I 2025-11-03 13:30:01,352] Trial 141 finished with value: 0.07542444273808555 and parameters: {'lambda\_l1': 0.16920898416197927, 'lambda\_l2': 0.011934478170359825, 'num\_leaves': 120, 'feature\_fraction': 0.6194693086427945, 'bagging\_fraction': 0.8633601445211511, 'bagging\_freq': 2, 'min\_child\_samples': 96, 'learning\_rate': 0.016147778911942797, 'n\_estimators': 700, 'max\_depth': 10}. Best is trial 130 with value 0.07538118899749845.  
[I 2025-11-03 13:30:42,487] Trial 142 finished with value: 0.07544252668162116 and parameters: {'lambda\_l1': 0.2604253733892108, 'lambda\_l2': 0.0021039064408791587, 'num\_leaves': 134, 'feature\_fraction': 0.6360825896097676, 'bagging\_fraction': 0.93725236341369, 'bagging\_freq': 5, 'min\_child\_samples': 92, 'learning\_rate': 0.013639099163654569, 'n\_estimators': 700, 'max\_depth': 10}. Best is trial 130 with value 0.07538118899749845.  
[I 2025-11-03 13:31:24,731] Trial 143 finished with value: 0.0754033814275088 and parameters: {'lambda\_l1': 0.08507595716081706, 'lambda\_l2': 0.03129037458310669, 'num\_leaves': 152, 'feature\_fraction': 0.6785352349424373, 'bagging\_fraction': 0.9206162352044653, 'bagging\_freq': 4, 'min\_child\_samples': 100, 'learning\_rate': 0.01924471641578539, 'n\_estimators': 700, 'max\_depth': 11}. Best is trial 130 with value 0.07538118899749845.  
[I 2025-11-03 13:31:54,837] Trial 144 finished with value: 0.0754210831923482 and parameters: {'lambda\_l1': 0.08422277318828683, 'lambda\_l2': 0.034576106650151726, 'num\_leaves': 153, 'feature\_fraction': 0.673806077621383, 'bagging\_fraction': 0.9662683204919778, 'bagging\_freq': 1, 'min\_child\_samples': 100, 'learning\_rate': 0.020036247616563113, 'n\_estimators': 700, 'max\_depth': 11}. Best is trial 130 with value 0.07538118899749845.

```

0.07538118899749845.
[I 2025-11-03 13:32:30,214] Trial 145 finished with value: 0.07543022546214827 and
parameters: {'lambda_l1': 0.12613487669687914, 'lambda_l2': 0.02048856949922706,
'num_leaves': 113, 'feature_fraction': 0.6833299752272645, 'bagging_fraction':
0.9472183142292989, 'bagging_freq': 5, 'min_child_samples': 98, 'learning_rate':
0.023433566463732177, 'n_estimators': 700, 'max_depth': 11}. Best is trial 130 with v
0.07538118899749845.
[I 2025-11-03 13:33:09,878] Trial 146 finished with value: 0.0754146877205718 and
parameters: {'lambda_l1': 0.06266891791381451, 'lambda_l2': 0.04596060028544071,
'num_leaves': 130, 'feature_fraction': 0.6646354081389182, 'bagging_fraction':
0.8320139432854856, 'bagging_freq': 4, 'min_child_samples': 97, 'learning_rate':
0.018325200062145875, 'n_estimators': 700, 'max_depth': 10}. Best is trial 130 with v
0.07538118899749845.
[I 2025-11-03 13:33:50,717] Trial 147 finished with value: 0.07547618217838384 and
parameters: {'lambda_l1': 0.04073051133004371, 'lambda_l2': 0.029364639789611232,
'num_leaves': 160, 'feature_fraction': 0.7041451490121627, 'bagging_fraction':
0.9195035142410015, 'bagging_freq': 4, 'min_child_samples': 100, 'learning_rate':
0.029234781474019915, 'n_estimators': 700, 'max_depth': 9}. Best is trial 130 with v
0.07538118899749845.
[I 2025-11-03 13:34:24,722] Trial 148 finished with value: 0.07539273745438817 and
parameters: {'lambda_l1': 0.06030983088451476, 'lambda_l2': 0.0626539976920368,
'num_leaves': 141, 'feature_fraction': 0.6548681166314471, 'bagging_fraction':
0.9052728859408025, 'bagging_freq': 5, 'min_child_samples': 95, 'learning_rate':
0.02189449648188791, 'n_estimators': 600, 'max_depth': 11}. Best is trial 130 with v
0.07538118899749845.
[I 2025-11-03 13:34:55,885] Trial 149 finished with value: 0.07544916893283025 and
parameters: {'lambda_l1': 0.05414571854902754, 'lambda_l2': 0.0628982080019231,
'num_leaves': 137, 'feature_fraction': 0.6485056043641254, 'bagging_fraction':
0.9041865217003465, 'bagging_freq': 5, 'min_child_samples': 38, 'learning_rate':
0.021984212667789497, 'n_estimators': 600, 'max_depth': 11}. Best is trial 130 with v
0.07538118899749845.
✓ Best LGBMRegressor parameters: {'lambda_l1': 0.11245392538961946, 'lambda_l2':
0.0035004125545440475, 'num_leaves': 117, 'feature_fraction': 0.6811929713430782,
'bagging_fraction': 0.8360385865874116, 'bagging_freq': 4, 'min_child_samples': 100,
'learning_rate': 0.018256386451821698, 'n_estimators': 800, 'max_depth': 10}

```

✂ Evaluating Tuned Models on GPU...

XGBRegressor (GPU)	MSE: 0.07545   MAE: 0.15364   R <sup>2</sup> : 0.53193
LGBMRegressor (GPU)	MSE: 0.07543   MAE: 0.15329   R <sup>2</sup> : 0.53208

```

In [16]: # Select best model
best_idx = np.argmin(mse_scores)
best_model_name = model_names[best_idx]
best_model = models[best_idx][1]
print(f"\n✓ Best Model Based on MSE: {best_model_name}")

```

✓ Best Model Based on MSE: LGBMRegressor (GPU)

```

In [17]: # Evaluate final model
y_pred = best_model.predict(X_test_scaled)
mse_default = mean_squared_error(y_test, y_pred)
mae_default = mean_absolute_error(y_test, y_pred)
r2_default = r2_score(y_test, y_pred)

print("\n✓ Final Model Evaluation:")
print(f"Mean Squared Error : {mse_default:.5f}")
print(f"Mean Absolute Error: {mae_default:.5f}")
print(f"R2 Score : {r2_default:.5f}")

```



✓ Final Model Evaluation:  
Mean Squared Error : 0.07543  
Mean Absolute Error: 0.15329  
R<sup>2</sup> Score : 0.53208

```
In [18]: print("\n🔧 Retraining the best model on full training data...")

# Prepare full training features and target
X_full = train_processed.drop(columns=['loan_paid_back'], errors='ignore')
y_full = train_processed['loan_paid_back']

# Ensure all columns are numeric
X_full = X_full.select_dtypes(include=[np.number])

# --- Re-fit the scaler on the FULL training data ---
# Your original 'scaler' variable is re-fit here, which is correct.
if scaler is not None:
    X_full_scaled = scaler.fit_transform(X_full)
else:
    X_full_scaled = X_full

# Retrain best model on the full scaled dataset
best_model.fit(X_full_scaled, y_full)

print(f"✓ Model retrained successfully: {best_model_name} ({best_model.__class__})")
```

🔧 Retraining the best model on full training data...

✓ Model retrained successfully: LGBMRegressor (GPU) (LGBMRegressor)

## Selecting best model and Generating Submission

```
In [19]: print("\n📄 Generating predictions using the best model...")

# Use the 'test_processed' dataframe we already created in Section 4
# Ensure numeric columns only and align column order
X_submission = test_processed.select_dtypes(include=[np.number])
X_submission = X_submission[X_full.columns] # Align column order to match training data

# Scale using the scaler that was just re-fit on X_full
if scaler is not None:
    X_submission_scaled = scaler.transform(X_submission)
else:
    X_submission_scaled = X_submission

# --- THIS IS THE MISSING LINE ---
# Generate the final predictions
submission_preds_raw = best_model.predict(X_submission_scaled)

# Clip the predictions
submission_preds = np.clip(submission_preds_raw, 0, 1)

# --- Create Submission File ---
submission = pd.DataFrame({
    'id': test_ids, # This was correctly defined at the top
    'loan_paid_back': submission_preds
})
submission.to_csv('submission.csv', index=False)
```

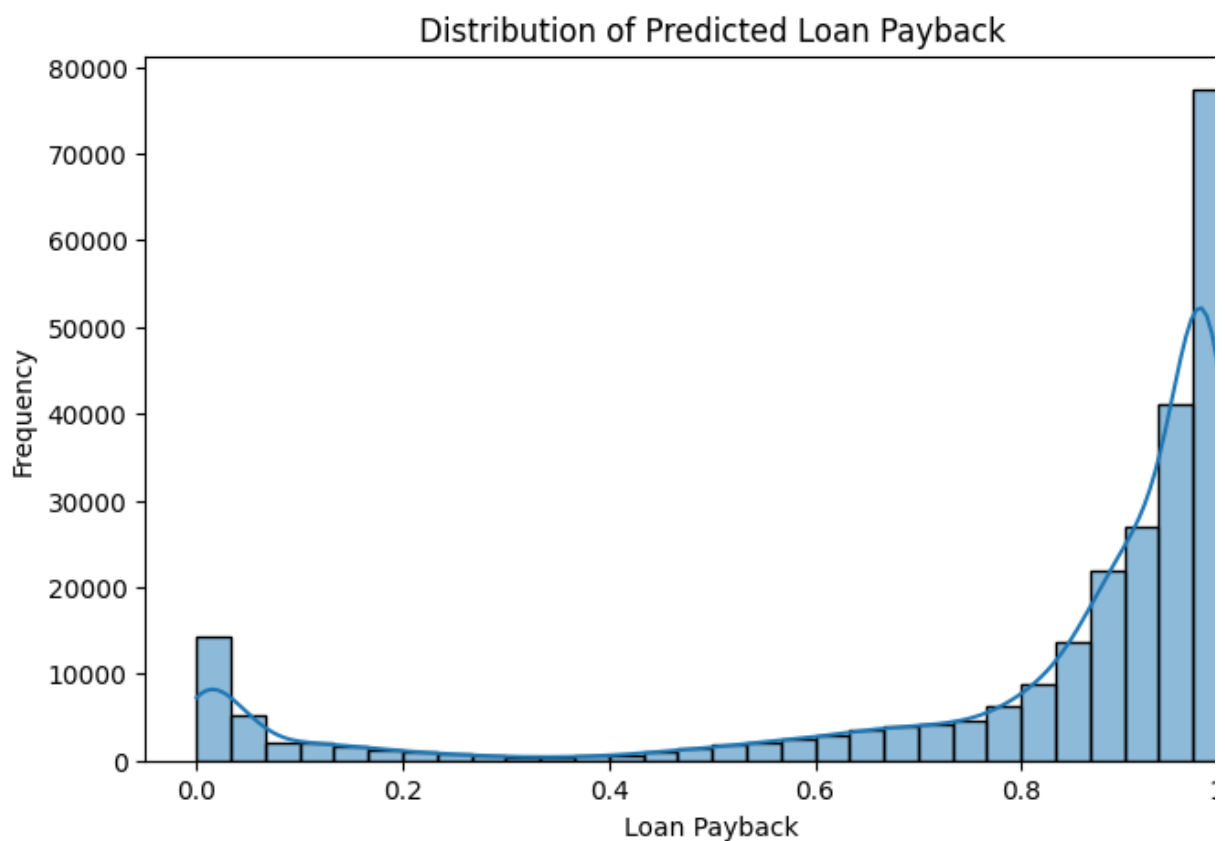
```
print("\n✔ Submission file 'submission.csv' generated successfully!")
display(submission.head())
```

🔗 Generating predictions using the best model...

✔ Submission file 'submission.csv' generated successfully!

	id	loan_paid_back
0	593994	0.958405
1	593995	0.961673
2	593996	0.515848
3	593997	0.963884
4	593998	0.986083

```
In [20]: # --- Final Plot ---
plt.figure(figsize=(8, 5))
sns.histplot(submission['loan_paid_back'], bins=30, kde=True)
plt.title('Distribution of Predicted Loan Payback')
plt.xlabel('Loan Payback')
plt.ylabel('Frequency')
plt.show()
```



In [ ]: