ADtutorial

July 10, 2024

1 Intro to Anomaly Detection with PyOD(Python Outlier Detection) and ADbench

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Anomaly detection involves identifying observations that deviate significantly from the norm. It is a key component of data quality processes (DQ), along with missing value imputation and data drift.

PyOD is a comprehensive library for detecting outliers in multivariate data. It provides various algorithms and utilities for anomaly detection.

ADbench is a set of benchmark datasets pooled from a large number of published papers and previously used open-source datasets. For this notebook, we are only using the ADbench datasets, so these can be downloaded separately if you have issues with installing ADbench (eg dependency clashes).

Shap is a library for implementing the SHAP (Shapley Additive exPlanations) explainability framework. It provides both model-specific and model-agnostic approaches for ML explainability.

1.1 1. Setup and Installation

Let's start by installing the required libraries. It is strongly recommended to build inside a dedicated environment.

[4]:
```
import warnings
warnings.filterwarnings("ignore")

#%pip install pyod #adbench matplotlib seaborn shap
```

We also need to download the datasets for ADbench

from adbench.myutils import Utils utils = Utils() # utility function # download datasets from the remote github repo utils.download_datasets(repo='github')

[5]:
```
#!pip install shap matplotlib
```

1.2 2. Load and Explore an ADbench Dataset

[6]:
```
# Import necessary libraries
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
#import seaborn as sns
from pyod.models.knn import KNN
from pyod.models.iforest import IForest
# Example anomaly detector
import shap  # For SHAP values explanation
```

2 Load a dataset from ADbench

adbench_dir = '/path/to/your/environment/eg/lib/python3.11/site-packages/adbench/datasets/Classical/' # change this to your adbench directory dataset_name = '2_annthyroid.npz' # You can change this to another dataset, see https://github.com/Minqi824/ADBench/tree/main/adbench/datasets/Classical data = np.load(adbench_dir+dataset_name, allow_pickle=True) X, y = data['X'], data['y']

[7]:
```
import pandas as pd
data=pd.read_csv('annthyroid.csv')
#data.columns=['A','B','C','D','E','F','label']
#data = data.drop(["Unnamed: 22", "Unnamed: 23"], axis=1)
data = data.rename({'label ': 'Outlier_label'}, axis=1)
data.head()
```

[7]:

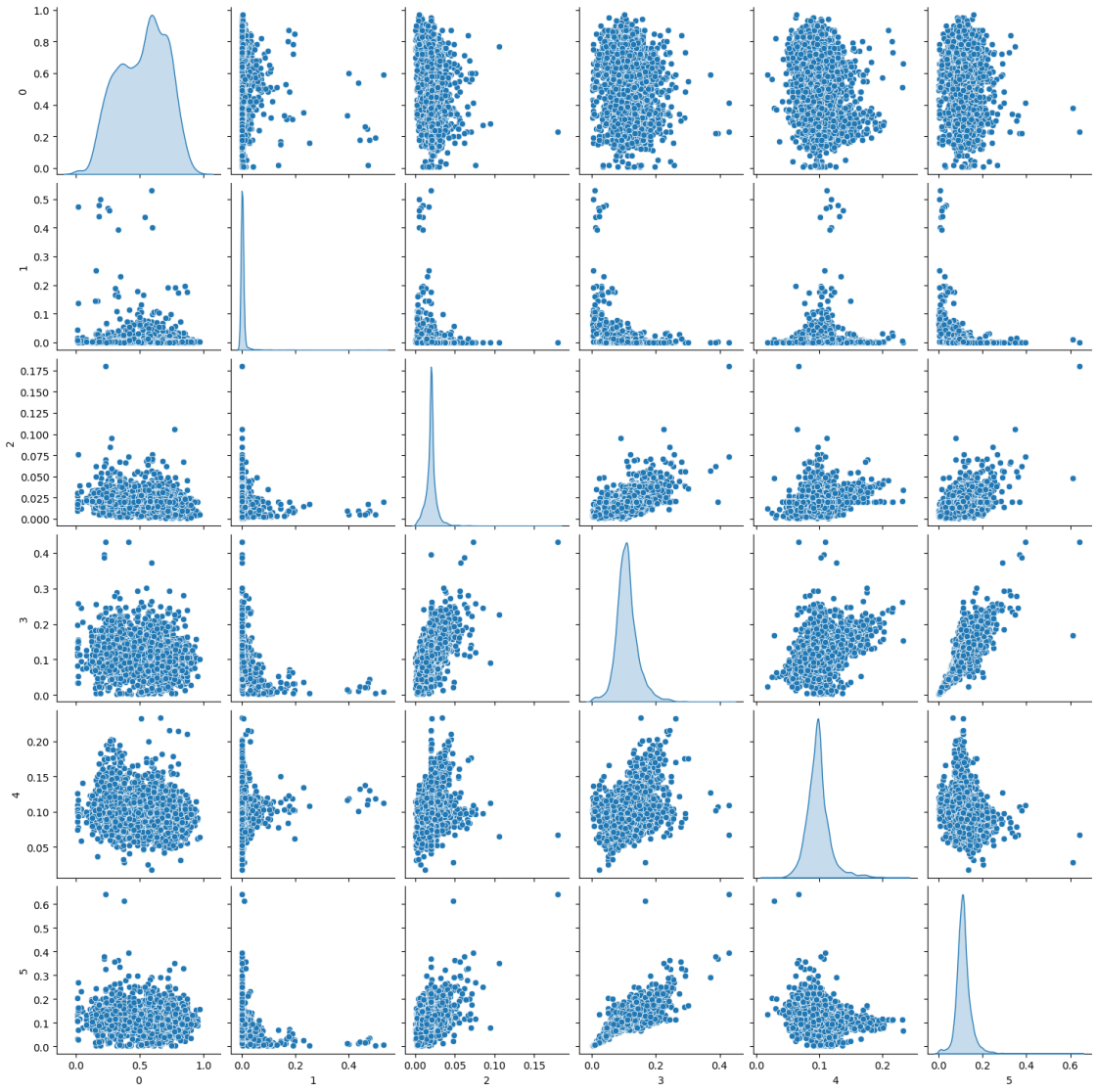
	0	1	2	3	4	5	label
0	0.73	0.00060	0.015	0.120	0.082	0.146	0
1	0.24	0.00025	0.030	0.143	0.133	0.108	0
2	0.47	0.00190	0.024	0.102	0.131	0.078	0
3	0.64	0.00090	0.017	0.077	0.090	0.085	0
4	0.23	0.00025	0.026	0.139	0.090	0.153	0

[8]:
```
X = data.drop("label", axis=1).values

y = data["label"]
```

[9]:
```
# split the data into training and testing sets
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3,␣
 ↪random_state=42, stratify=y)

#print(f"Dataset: {dataset_name}")
print(f"Training set shape: {X_train.shape}")
print(f"Test set shape: {X_test.shape}")
```

```
Training set shape: (5040, 6)
Test set shape: (2160, 6)
```

[10]:
```
import seaborn as sns
# Visualize the data distribution (use a subset if too large)
sns.pairplot(pd.DataFrame(X_train), diag_kind='kde')
plt.show()
```



3 3. Using PyOD for Anomaly Detection

3.1 (a) KNN

[11]:
```
# Initialize a PyOD model (KNN as an example)
clf = KNN()
# Train the model
clf.fit(X_train)

# Predict anomalies on the test set
y_test_pred = clf.predict(X_test)
y_test_scores = clf.decision_function(X_test)
```

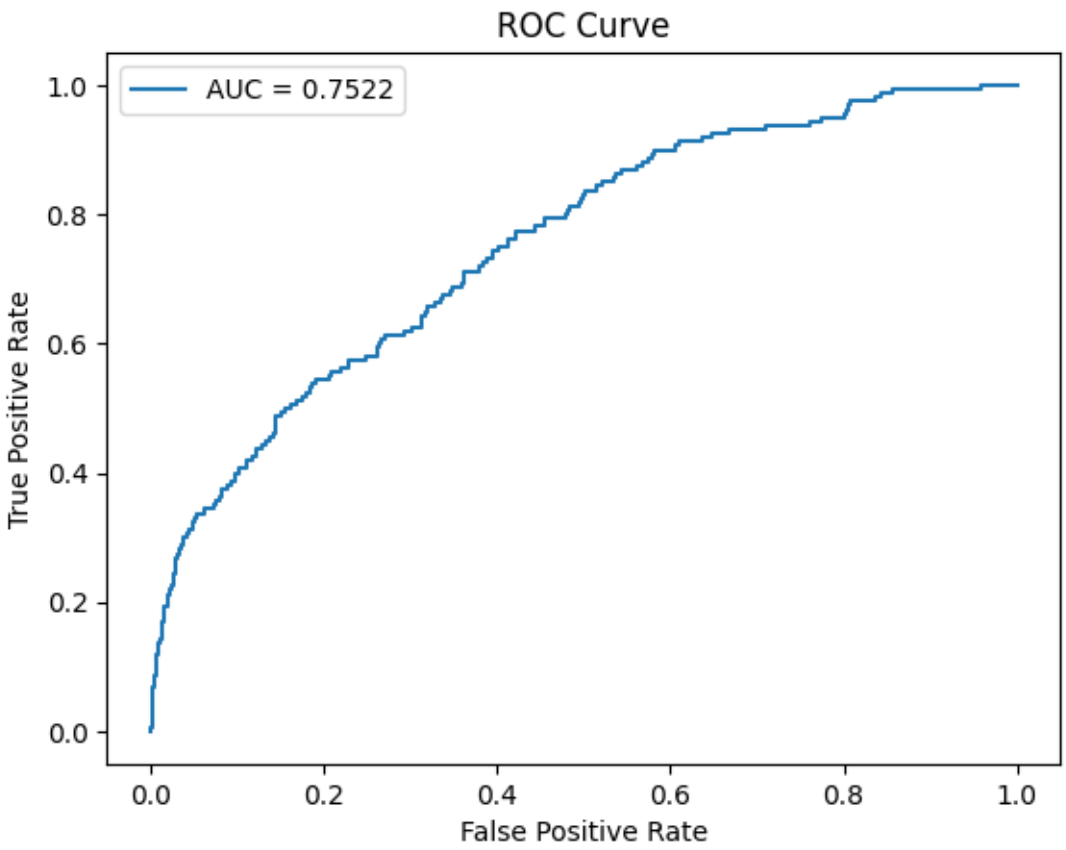
3.2 4. Evaluating Anomaly Detection Model Performance

[12]:
```
from sklearn.metrics import roc_auc_score, accuracy_score

# Evaluate the model
auc = roc_auc_score(y_test, y_test_scores)
accuracy = accuracy_score(y_test, y_test_pred)
auc_knn=auc
accuracy_knn=accuracy
print(f"ROC AUC: {auc:.4f}")
print(f"Accuracy: {accuracy:.4f}")
```

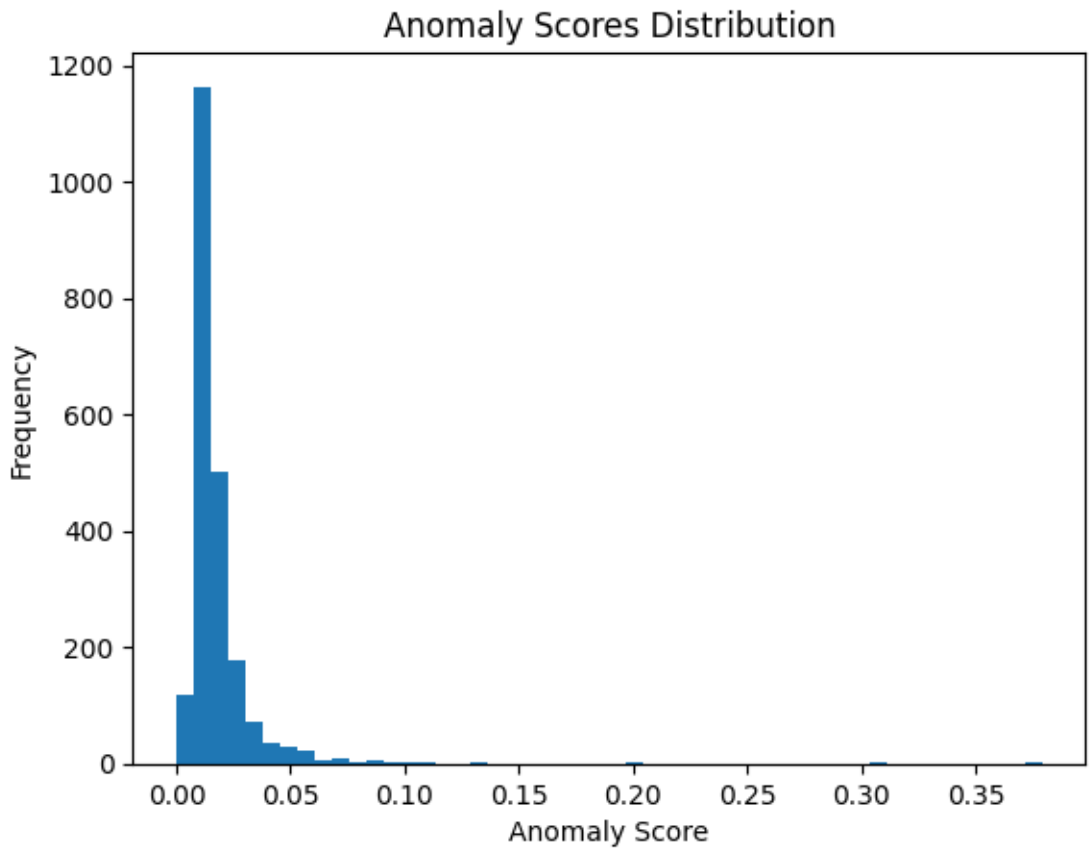
```
ROC AUC: 0.7522
Accuracy: 0.8861
```

3.3 5. Visualizing Results

[13]:
```
# Plot ROC Curve
from sklearn.metrics import roc_curve

fpr, tpr, thresholds = roc_curve(y_test, y_test_scores)
plt.plot(fpr, tpr, label=f'AUC = {auc:.4f}')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('ROC Curve')
plt.legend(loc='best')
plt.show()
```



[14]:
```
# Visualize anomaly scores
plt.hist(y_test_scores, bins=50)
plt.xlabel('Anomaly Score')
plt.ylabel('Frequency')
plt.title('Anomaly Scores Distribution')
plt.show()
```



[15]:
```
# Visualize the data distribution (use a subset if too large), coloring true positives, false positives, true negatives, and false negatives
df = pd.DataFrame(X_train)
df['y'] = y_train
df['y_pred'] = clf.predict(X_train)
```

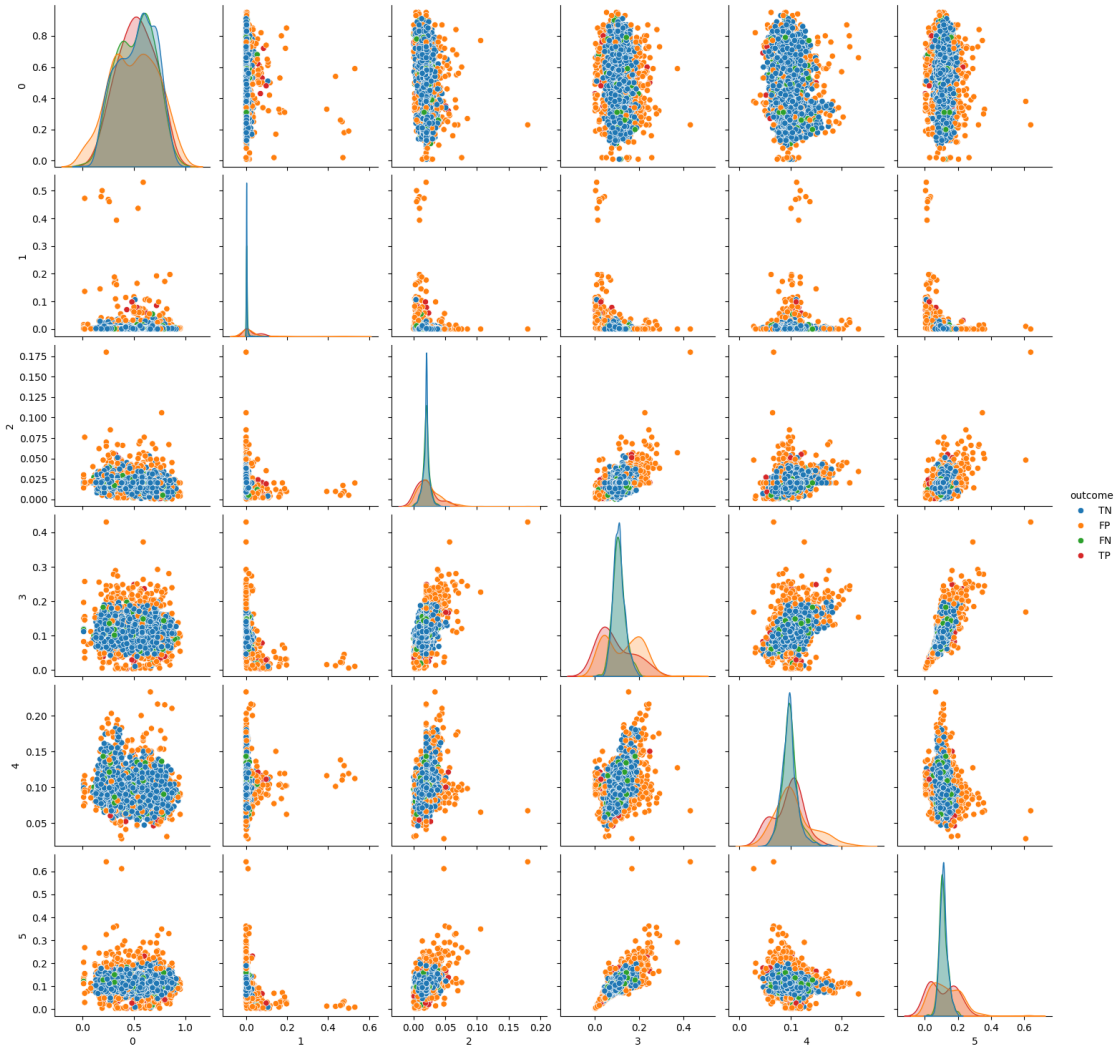
[16]:
```
def label_outcome(row):
    if row['y'] == 1 and row['y_pred'] == 1:
        return 'TP'  # True Positive
    elif row['y'] == 0 and row['y_pred'] == 1:
        return 'FP'  # False Positive
    elif row['y'] == 0 and row['y_pred'] == 0:
        return 'TN'  # True Negative
    elif row['y'] == 1 and row['y_pred'] == 0:
        return 'FN'  # False Negative
```

[17]:
```
df['outcome'] = df.apply(label_outcome, axis=1)
df = df.drop(['y', 'y_pred'], axis=1)
df.head()
```

[17]:

	0	1	2	3	4	5	outcome
0	0.28	0.00208	0.017	0.116	0.101	0.115	TN
1	0.74	0.00300	0.012	0.096	0.093	0.103	None
2	0.85	0.00140	0.006	0.124	0.096	0.129	None
3	0.34	0.00680	0.024	0.096	0.104	0.090	None
4	0.46	0.00091	0.024	0.124	0.104	0.118	None

[18]:
```
# Visualize the data distribution (use a subset if too large), coloring true positives, false positives, true negatives, and false negatives

pp = sns.pairplot(df, diag_kind='kde', hue='outcome',  # color by outcome
                  diag_kws=dict(common_norm=False))  # scale kde independently for each outcome
plt.show()
```



3.4 6. Explainability with SHAP

[19]:
```
# find index of first true positive
first_tp_index = df[df['outcome'] == 'TP'].index[0]
print(f"Index of the first True Positive: {first_tp_index}")
```

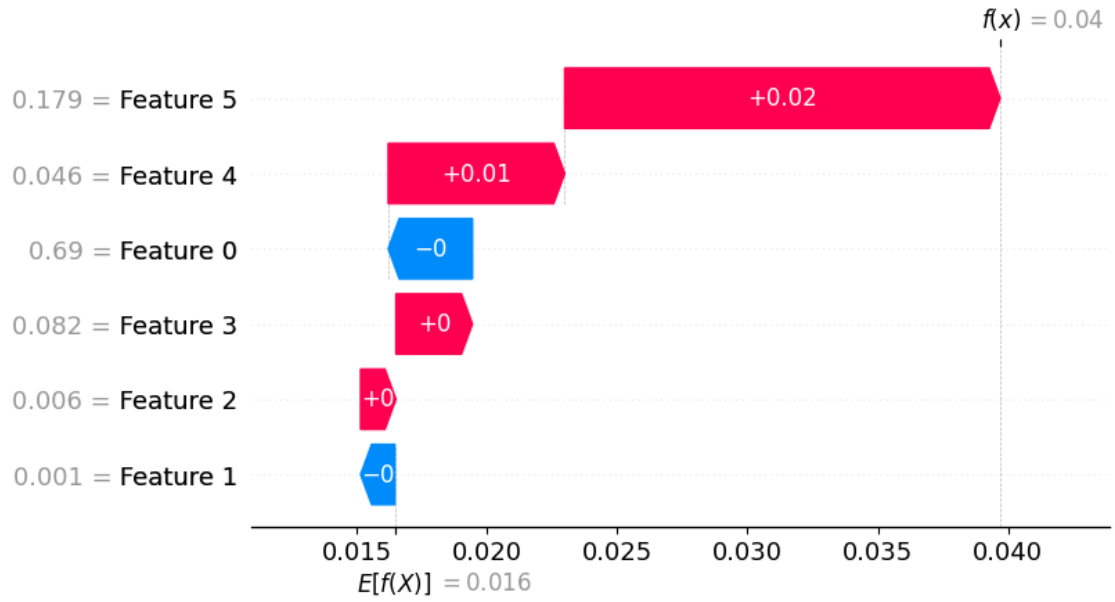
```
Index of the first True Positive: 115
```

[20]:
```
!pip3 install numpy==1.23.1
```

```
Looking in indexes: https://pypi.org/simple, https://pypi.ngc.nvidia.com
Requirement already satisfied: numpy==1.23.1 in
/opt/anaconda3/envs/Project/lib/python3.8/site-packages (1.23.1)

[notice] A new release of pip is
available: 24.1.1 -> 24.1.2
[notice] To update, run:
pip install --upgrade pip
```

[21]:
```
import numpy as np
np.bool = np.bool_
np.int=np.int_
```

[22]:
```
# Fit SHAP explainer and obtain SHAP values for one observation -- TRUE POSITIVE
explainer = shap.explainers.Exact(clf.decision_function, X_train)
shap_values_exact = explainer(np.array([X_train[first_tp_index,]]))
shap.plots.waterfall(shap_values_exact[0])
```



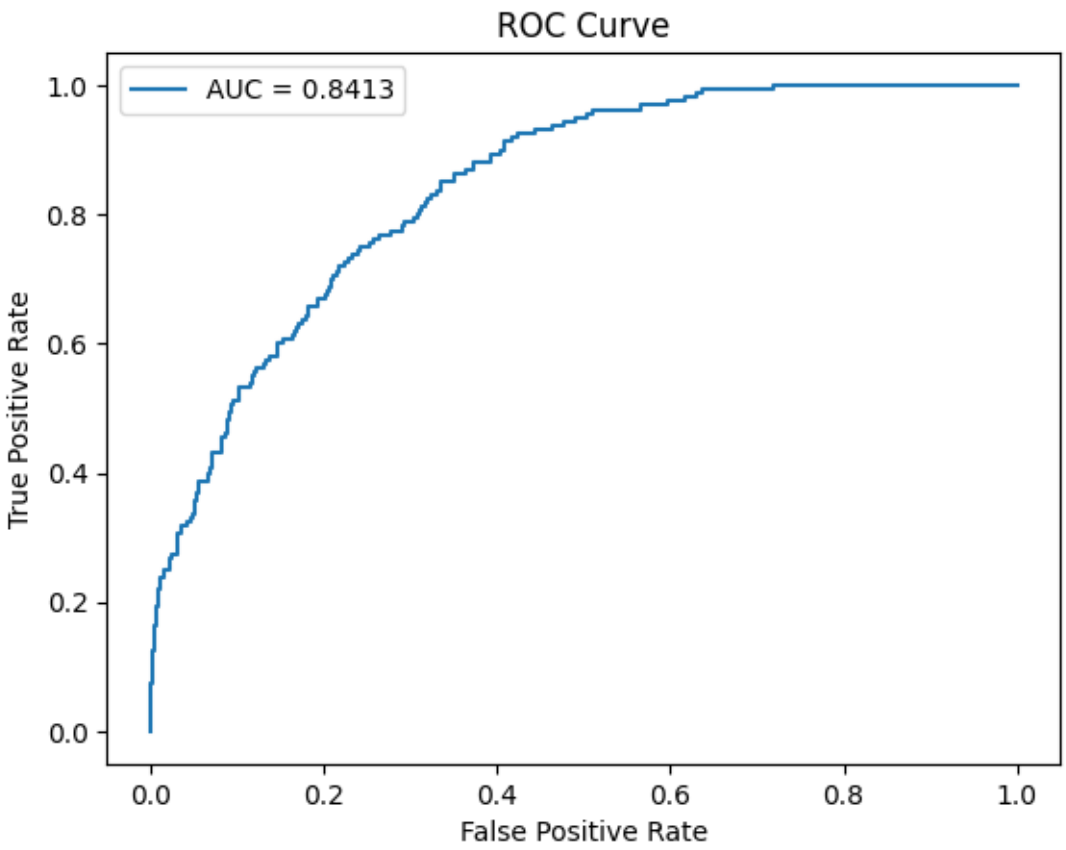
4 (b) Isolation Forest

[23]:
```
# Initialize a PyOD model (KNN as an example)
clf = IForest()
# Train the model
clf.fit(X_train)

# Predict anomalies on the test set
y_test_pred = clf.predict(X_test)
y_test_scores = clf.decision_function(X_test)
```

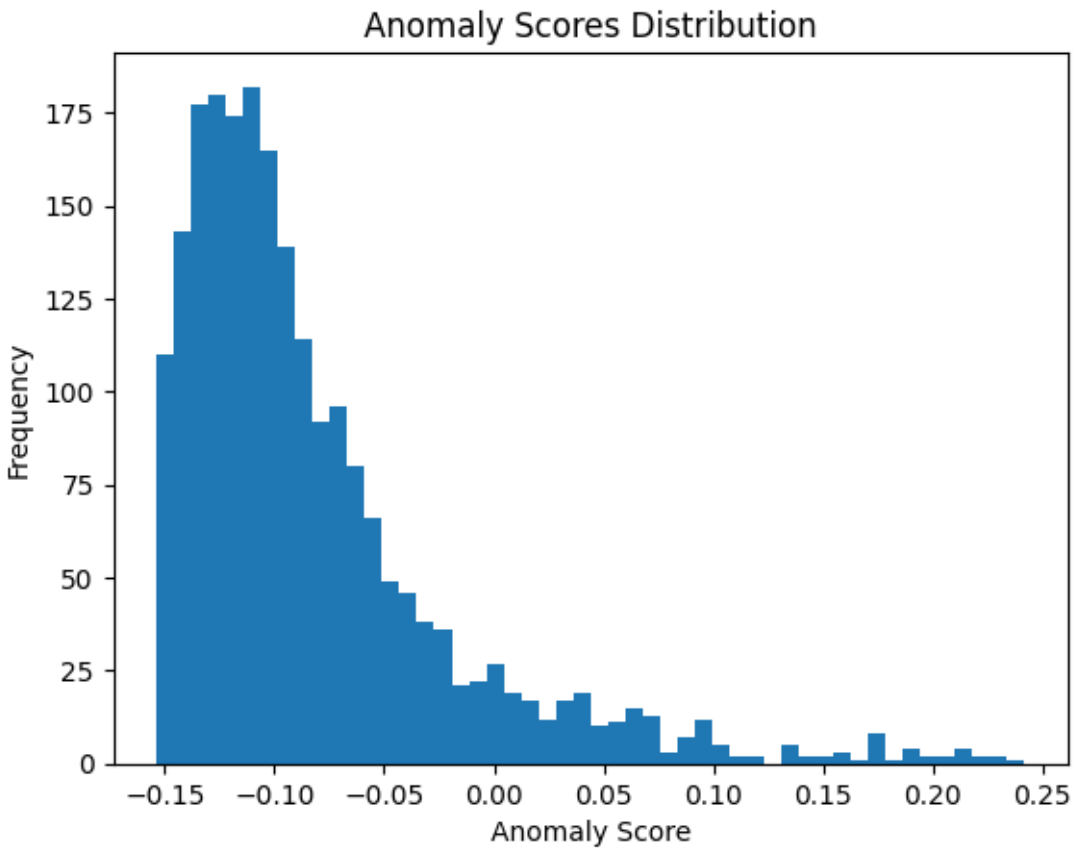
[24]:
```
from sklearn.metrics import roc_auc_score, accuracy_score

# Evaluate the model
auc = roc_auc_score(y_test, y_test_scores)
accuracy = accuracy_score(y_test, y_test_pred)
auc_IF=auc
accuracy_IF=accuracy

print(f"ROC AUC: {auc:.4f}")
print(f"Accuracy: {accuracy:.4f}")
```

```
ROC AUC: 0.8413
Accuracy: 0.8912
```

[25]:
```
# Plot ROC Curve
from sklearn.metrics import roc_curve

fpr, tpr, thresholds = roc_curve(y_test, y_test_scores)
plt.plot(fpr, tpr, label=f'AUC = {auc:.4f}')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('ROC Curve')
plt.legend(loc='best')
plt.show()
```



[26]:
```
# Visualize anomaly scores
plt.hist(y_test_scores, bins=50)
plt.xlabel('Anomaly Score')
plt.ylabel('Frequency')
plt.title('Anomaly Scores Distribution')
plt.show()
```



[27]:
```
# Visualize the data distribution (use a subset if too large), coloring true positives, false positives, true negatives, and false negatives
df = pd.DataFrame(X_train)
df['y'] = y_train
df['y_pred'] = clf.predict(X_train)
```

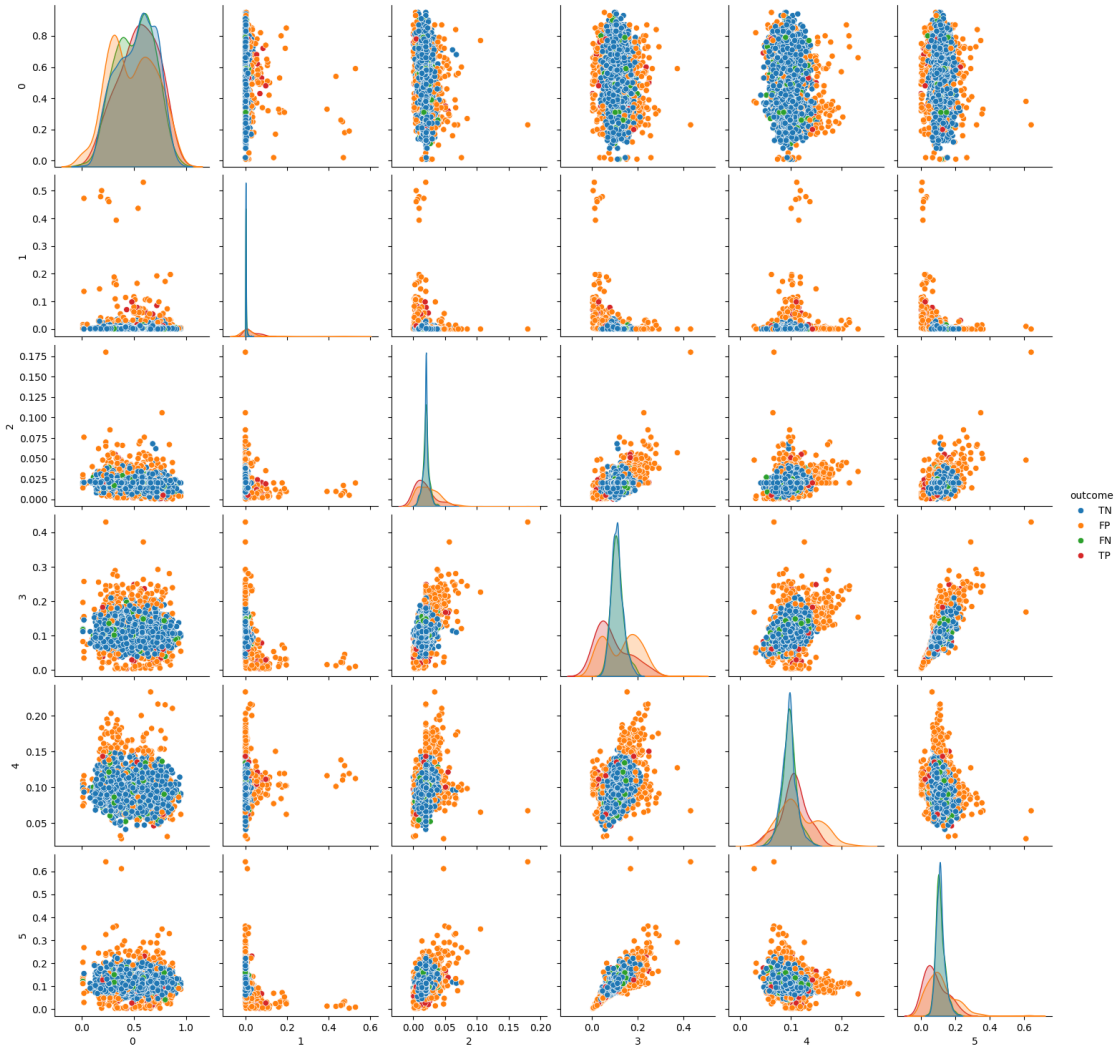
[28]:
```
def label_outcome(row):
    if row['y'] == 1 and row['y_pred'] == 1:
        return 'TP'  # True Positive
    elif row['y'] == 0 and row['y_pred'] == 1:
        return 'FP'  # False Positive
    elif row['y'] == 0 and row['y_pred'] == 0:
        return 'TN'  # True Negative
    elif row['y'] == 1 and row['y_pred'] == 0:
        return 'FN'  # False Negative
```

[29]:
```
df['outcome'] = df.apply(label_outcome, axis=1)
df = df.drop(['y', 'y_pred'], axis=1)
df.head()
```

[29]:

	0	1	2	3	4	5	outcome
0	0.28	0.00208	0.017	0.116	0.101	0.115	TN
1	0.74	0.00300	0.012	0.096	0.093	0.103	None
2	0.85	0.00140	0.006	0.124	0.096	0.129	None
3	0.34	0.00680	0.024	0.096	0.104	0.090	None
4	0.46	0.00091	0.024	0.124	0.104	0.118	None

[30]:
```
# Visualize the data distribution (use a subset if too large), coloring true positives, false positives, true negatives, and false negatives

pp = sns.pairplot(df, diag_kind='kde', hue='outcome',  # color by outcome
                  diag_kws=dict(common_norm=False))  # scale kde independently for each outcome
plt.show()
```

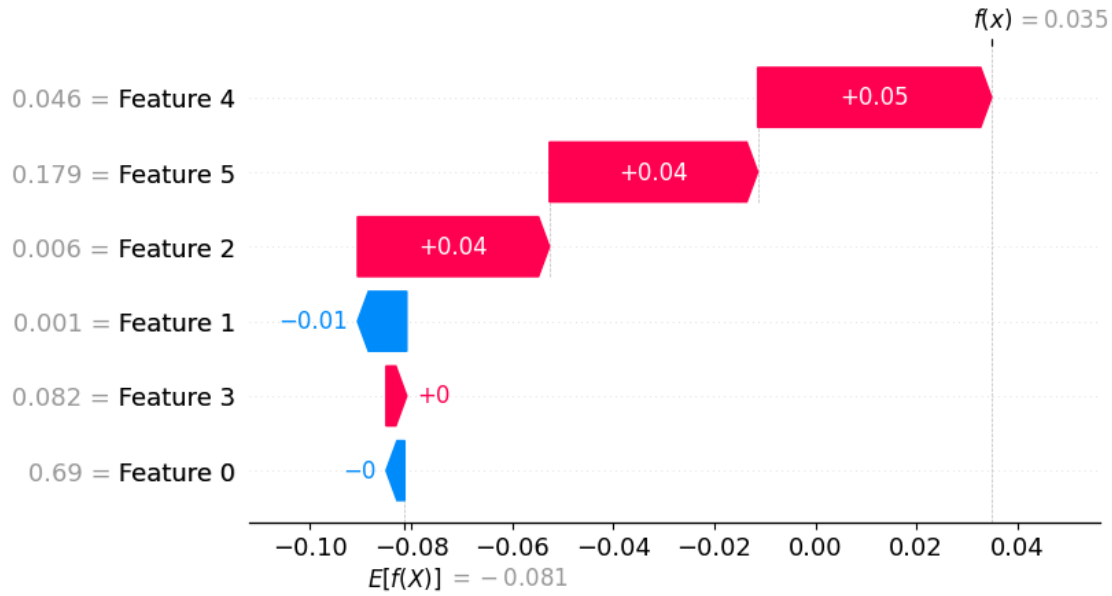


4.1 6. Explainability with SHAP

[31]:
```
# find index of first true positive
first_tp_index = df[df['outcome'] == 'TP'].index[0]
print(f"Index of the first True Positive: {first_tp_index}")
```

```
Index of the first True Positive: 115
```

[32]:
```
# Fit SHAP explainer and obtain SHAP values for one observation -- TRUE POSITIVE
explainer = shap.explainers.Exact(clf.decision_function, X_train)
shap_values_exact = explainer(np.array([X_train[first_tp_index,]]))
shap.plots.waterfall(shap_values_exact[0])
```



5 PARAMETER TUNING

import numpy as np from sklearn.model_selection import GridSearchCV from sklearn.metrics import roc_auc_score from pyod.models.knn import KNN

6 Assuming X_train, X_test, y_train, y_test are already defined

7 Define the model

model = KNN()

8 Define parameter grid

param_grid = { ‘n_neighbors’: [5, 10, 15, 20, 25], ‘method’: [‘largest’, ‘mean’, ‘median’], ‘algorithm’: [‘auto’, ‘ball_tree’, ‘kd_tree’, ‘brute’], ‘leaf_size’: [10, 20, 30, 40], ‘metric’: [‘euclidean’, ‘manhattan’, ‘chebyshev’, ‘minkowski’] }

9 Define evaluation metric (ROC AUC in this case)

scoring = ‘roc_auc’

10 Perform grid search with cross-validation

grid_search = GridSearchCV(estimator=model, param_grid=param_grid, scoring=scoring, cv=3, verbose=1) grid_search.fit(X_train)

11 Print the best parameters and best score

print(“Best parameters found:”, grid_search.best_params_) print(“Best ROC AUC score found:”, grid_search.best_score_)

12 Evaluate on test data

y_pred = grid_search.predict(X_test) roc_auc = roc_auc_score(y_true=y_test, y_score=-grid_search.best_estimator_.decision_function(X_test)) print(“ROC AUC on test data:”, roc_auc)

import numpy as np from sklearn.model_selection import GridSearchCV from sklearn.metrics import roc_auc_score from pyod.models.iforest import IForest

13 Define the model

model = IForest(random_state=42)

14 Define parameter grid

param_grid = { ‘n_estimators’: [50, 100, 200], ‘max_samples’: [100, 200, ‘auto’], ‘contamination’: [0.05, 0.1, 0.2] }

15 Define evaluation metric (ROC AUC in this case)

scoring = ‘roc_auc’

16 Perform grid search with cross-validation

grid_search = GridSearchCV(estimator=model, param_grid=param_grid, scoring=scoring, cv=3, verbose=1) grid_search.fit(X_train)

17 Print the best parameters and best score

print(“Best parameters found:”, grid_search.best_params_) print(“Best ROC AUC score found:”, grid_search.best_score_) # Evaluate on test data y_pred = grid_search.predict(X_test) roc_auc = roc_auc_score(y_true=y_test, y_score=-grid_search.decision_function(X_test)) # Assuming y_true is 0 for all test samples print(“ROC AUC on test data:”, roc_auc)

18 Internal GDL project

19 TUNING USING GRIDSEARCH

19.1 *1. How do different unsupervised anomaly detectors perform across different datasets?*

Limit research to unsupervised anomaly detectors, on the following ADbench datasets: * annthyroid, * campaign, * census, * donors, and * skin

Evaluate performance of AD methods using AUC-ROC. Keep in mind different methods have different hyperparameters. Optimizing hyperparameters requires cross-validation.

19.1.1 Hints

You may want to subsample datasets to reduce computational load—make sure to stratify on y to preserve class balance of inliers/outliers.

While you can run each dataset as a single experiment, it may be more efficient to build a pipeline.

KNN: K-Nearest Neighbors

LOF: Local Outlier Factor

HBOS: Histogram-based Outlier Score

IForest: Isolation Forest

PCA: Principal Component Analysis

MCD: Minimum Covariance Determinant

OCSVM: One-Class Support Vector Machine

ABOD: Angle-Based Outlier Detection

AutoEncoder: AutoEncoder

VAE: Variational AutoEncoder

LSCP: LSCP (Locally Selective Combination of Parallel Outlier Ensembles)

COF: Connectivity-Based Outlier Factor

LOCI: LOCI (Local Correlation Integral)

SOD: Subspace Outlier Detection

[34]:
```
import numpy as np
from sklearn.model_selection import train_test_split, GridSearchCV
from sklearn.metrics import roc_auc_score
from pyod.models.knn import KNN
from pyod.models.lof import LOF
from pyod.models.hbos import HBOS
from pyod.models.iforest import IForest
from pyod.models.pca import PCA
from pyod.models.mcd import MCD
from pyod.models.ocsvm import OCSVM
from pyod.models.abod import ABOD
from pyod.models.auto_encoder import AutoEncoder
from pyod.models.vae import VAE
from pyod.models.lscp import LSCP
from pyod.models.cof import COF
from pyod.models.loci import LOCI
from pyod.models.sod import SOD
from pyod.models.kde import KDE
```

[ ]:
```
# Load your dataset and split into train and test sets
# Assuming X contains your features and y contains your labels or anomalies
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3,␣
 ↪random_state=42, stratify=y)

# Define models to evaluate
models = {
    'KNN': KNN(),
    'LOF': LOF(),
    'HBOS': HBOS(),
    'IForest': IForest(),
    'PCA': PCA(),
    'MCD': MCD(),
    'OCSVM': OCSVM(),
    'KDE': KDE()
    #'ABOD': ABOD()
    #'COF': COF(),
    #'LOCI': LOCI(),
    #'SOD': SOD()
}

# Define parameter grids for each model
param_grids = {
    'KNN': {
        'n_neighbors': [5, 10, 15, 20],
        'method': ['largest', 'mean', 'median', 'distance'],
        'metric': ['euclidean', 'manhattan', 'chebyshev', 'minkowski'],
        'leaf_size': [10, 20, 30],
```

```
        'algorithm': ['auto', 'ball_tree', 'kd_tree', 'brute']
    },
    'LOF': {
        'n_neighbors': [5, 10, 15, 20],
        'algorithm': ['auto', 'ball_tree', 'kd_tree', 'brute'],
        'contamination': [0.01, 0.05, 0.1, 0.15],
        'metric': ['minkowski', 'manhattan', 'euclidean']
    },
    'HBOS': {
        'n_bins': [10, 20, 30, 40],
        'alpha': [0.1, 0.3, 0.6, 0.9],
        'contamination': [0.01, 0.05, 0.1, 0.15]
    },
    'IForest': {
        'n_estimators': [50, 100, 150, 200],
        'max_samples': [0.5, 0.7, 1.0],
        'contamination': [0.01, 0.05, 0.1, 0.15],
        'bootstrap': [True, False],
        'max_features': [0.5, 0.7, 1.0],
        'behaviour': ['new', 'old']
    },
    'PCA': {
        'n_components': [2, 5, 10, 20],
        'whiten': [True, False],
        'svd_solver': ['auto', 'full', 'arpack', 'randomized']
    },
    'MCD': {
        'contamination': [0.01, 0.05, 0.1, 0.15]
    },
    'OCSVM': {
        'kernel': ['rbf', 'linear', 'poly', 'sigmoid'],
        'nu': [0.01, 0.05, 0.1, 0.15],
        'gamma': ['auto', 'scale']
    },
    'KDE': {'contamination': [0.01, 0.05, 0.1, 0.15]}
}

# Perform grid search and tune models
best_models = {}
for name, model in models.items():
    param_grid = param_grids[name]
    grid_search = GridSearchCV(model, param_grid, scoring='roc_auc', cv=5,␣
 ↪verbose=1)
    grid_search.fit(X_train, y_train)
    best_model = grid_search.best_estimator_
    best_models[name] = best_model
```

```
# Print best models found by GridSearchCV
for name, model in best_models.items():
    print(f"Best model for {name}:")
    print(model)
    print()

# Example of evaluating models using ROC AUC score (or other appropriate␣
 ↪metrics)
results = {}
for name, model in best_models.items():
    y_scores = model.decision_function(X_test)
    roc_auc = roc_auc_score(y_test, y_scores)
    results[name] = roc_auc

# Print or analyze results
print("ROC AUC Scores:")
print(results)
```

[35]:
```
from flaml import AutoML

automl = AutoML()

# Specify automl goal and constraint
automl_settings = {
    "time_budget": 200,       # total running time in seconds
    "task": 'classification', # task type
    "seed": 24545678,         # random seed
    "metric": 'roc_auc',      # use ROC AUC as the metric
}

# Fit the AutoML model with the specified settings
automl.fit(X_train=X_train, y_train=y_train, **automl_settings)
```

```
[flaml.automl.logger: 07-10 09:41:47] {1680} INFO - task = classification
[flaml.automl.logger: 07-10 09:41:47] {1691} INFO - Evaluation method: cv
[flaml.automl.logger: 07-10 09:41:47] {1789} INFO - Minimizing error metric:
1-roc_auc
[flaml.automl.logger: 07-10 09:41:47] {1901} INFO - List of ML learners in
AutoML Run: ['lgbm', 'rf', 'xgboost', 'extra_tree', 'xgb_limitdepth', 'lrl1']
[flaml.automl.logger: 07-10 09:41:47] {2219} INFO - iteration 0, current learner
lgbm
[flaml.automl.logger: 07-10 09:41:47] {2345} INFO - Estimated sufficient time
budget=650s. Estimated necessary time budget=15s.
[flaml.automl.logger: 07-10 09:41:47] {2392} INFO -  at 0.1s,   estimator lgbm's
best error=0.0063,     best estimator lgbm's best error=0.0063
[flaml.automl.logger: 07-10 09:41:47] {2219} INFO - iteration 1, current learner
lgbm
[flaml.automl.logger: 07-10 09:41:47] {2392} INFO -  at 0.1s,   estimator lgbm's
```

```
best error=0.0063,     best estimator lgbm's best error=0.0063
[flaml.automl.logger: 07-10 09:41:47] {2219} INFO - iteration 2, current learner
lgbm
[flaml.automl.logger: 07-10 09:41:47] {2392} INFO -  at 0.2s,   estimator lgbm's
best error=0.0049,     best estimator lgbm's best error=0.0049
[flaml.automl.logger: 07-10 09:41:47] {2219} INFO - iteration 3, current learner
xgboost
[flaml.automl.logger: 07-10 09:41:47] {2392} INFO -  at 0.3s,   estimator
xgboost's best error=0.0126,  best estimator lgbm's best error=0.0049
[flaml.automl.logger: 07-10 09:41:47] {2219} INFO - iteration 4, current learner
lgbm
[flaml.automl.logger: 07-10 09:41:47] {2392} INFO -  at 0.4s,   estimator lgbm's
best error=0.0049,     best estimator lgbm's best error=0.0049
[flaml.automl.logger: 07-10 09:41:47] {2219} INFO - iteration 5, current learner
lgbm
[flaml.automl.logger: 07-10 09:41:47] {2392} INFO -  at 0.4s,   estimator lgbm's
best error=0.0049,     best estimator lgbm's best error=0.0049
[flaml.automl.logger: 07-10 09:41:47] {2219} INFO - iteration 6, current learner
lgbm
[flaml.automl.logger: 07-10 09:41:47] {2392} INFO -  at 0.5s,   estimator lgbm's
best error=0.0049,     best estimator lgbm's best error=0.0049
[flaml.automl.logger: 07-10 09:41:47] {2219} INFO - iteration 7, current learner
lgbm
[flaml.automl.logger: 07-10 09:41:47] {2392} INFO -  at 0.6s,   estimator lgbm's
best error=0.0049,     best estimator lgbm's best error=0.0049
[flaml.automl.logger: 07-10 09:41:47] {2219} INFO - iteration 8, current learner
lgbm
[flaml.automl.logger: 07-10 09:41:47] {2392} INFO -  at 0.6s,   estimator lgbm's
best error=0.0049,     best estimator lgbm's best error=0.0049
[flaml.automl.logger: 07-10 09:41:47] {2219} INFO - iteration 9, current learner
xgboost
[flaml.automl.logger: 07-10 09:41:47] {2392} INFO -  at 0.7s,   estimator
xgboost's best error=0.0126,  best estimator lgbm's best error=0.0049
[flaml.automl.logger: 07-10 09:41:47] {2219} INFO - iteration 10, current
learner extra_tree
[flaml.automl.logger: 07-10 09:41:47] {2392} INFO -  at 0.9s,   estimator
extra_tree's best error=0.2302,       best estimator lgbm's best error=0.0049
[flaml.automl.logger: 07-10 09:41:47] {2219} INFO - iteration 11, current
learner rf
[flaml.automl.logger: 07-10 09:41:48] {2392} INFO -  at 1.0s,   estimator rf's
best error=0.0101,       best estimator lgbm's best error=0.0049
[flaml.automl.logger: 07-10 09:41:48] {2219} INFO - iteration 12, current
learner rf
[flaml.automl.logger: 07-10 09:41:48] {2392} INFO -  at 1.1s,   estimator rf's
best error=0.0101,       best estimator lgbm's best error=0.0049
[flaml.automl.logger: 07-10 09:41:48] {2219} INFO - iteration 13, current
learner xgboost
[flaml.automl.logger: 07-10 09:41:48] {2392} INFO -  at 1.2s,   estimator
```

```
xgboost's best error=0.0086,  best estimator lgbm's best error=0.0049
[flaml.automl.logger: 07-10 09:41:48] {2219} INFO - iteration 14, current
learner rf
[flaml.automl.logger: 07-10 09:41:48] {2392} INFO -  at 1.4s,   estimator rf's
best error=0.0061,       best estimator lgbm's best error=0.0049
[flaml.automl.logger: 07-10 09:41:48] {2219} INFO - iteration 15, current
learner xgboost
[flaml.automl.logger: 07-10 09:41:48] {2392} INFO -  at 1.5s,   estimator
xgboost's best error=0.0086,  best estimator lgbm's best error=0.0049
[flaml.automl.logger: 07-10 09:41:48] {2219} INFO - iteration 16, current
learner lgbm
[flaml.automl.logger: 07-10 09:41:48] {2392} INFO -  at 1.5s,   estimator lgbm's
best error=0.0049,     best estimator lgbm's best error=0.0049
[flaml.automl.logger: 07-10 09:41:48] {2219} INFO - iteration 17, current
learner extra_tree
[flaml.automl.logger: 07-10 09:41:48] {2392} INFO -  at 1.7s,   estimator
extra_tree's best error=0.1999,       best estimator lgbm's best error=0.0049
[flaml.automl.logger: 07-10 09:41:48] {2219} INFO - iteration 18, current
learner lgbm
[flaml.automl.logger: 07-10 09:41:48] {2392} INFO -  at 1.7s,   estimator lgbm's
best error=0.0049,     best estimator lgbm's best error=0.0049
[flaml.automl.logger: 07-10 09:41:48] {2219} INFO - iteration 19, current
learner xgboost
[flaml.automl.logger: 07-10 09:41:48] {2392} INFO -  at 1.9s,   estimator
xgboost's best error=0.0059,  best estimator lgbm's best error=0.0049
[flaml.automl.logger: 07-10 09:41:48] {2219} INFO - iteration 20, current
learner rf
[flaml.automl.logger: 07-10 09:41:49] {2392} INFO -  at 2.1s,   estimator rf's
best error=0.0061,       best estimator lgbm's best error=0.0049
[flaml.automl.logger: 07-10 09:41:49] {2219} INFO - iteration 21, current
learner xgboost
[flaml.automl.logger: 07-10 09:41:49] {2392} INFO -  at 2.2s,   estimator
xgboost's best error=0.0054,  best estimator lgbm's best error=0.0049
[flaml.automl.logger: 07-10 09:41:49] {2219} INFO - iteration 22, current
learner lgbm
[flaml.automl.logger: 07-10 09:41:49] {2392} INFO -  at 2.2s,   estimator lgbm's
best error=0.0049,     best estimator lgbm's best error=0.0049
[flaml.automl.logger: 07-10 09:41:49] {2219} INFO - iteration 23, current
learner rf
[flaml.automl.logger: 07-10 09:41:49] {2392} INFO -  at 2.5s,   estimator rf's
best error=0.0061,       best estimator lgbm's best error=0.0049
[flaml.automl.logger: 07-10 09:41:49] {2219} INFO - iteration 24, current
learner xgboost
[flaml.automl.logger: 07-10 09:41:49] {2392} INFO -  at 2.6s,   estimator
xgboost's best error=0.0054,  best estimator lgbm's best error=0.0049
[flaml.automl.logger: 07-10 09:41:49] {2219} INFO - iteration 25, current
learner extra_tree
[flaml.automl.logger: 07-10 09:41:49] {2392} INFO -  at 2.7s,   estimator
```

```
extra_tree's best error=0.1999,       best estimator lgbm's best error=0.0049
[flaml.automl.logger: 07-10 09:41:49] {2219} INFO - iteration 26, current
learner rf
[flaml.automl.logger: 07-10 09:41:49] {2392} INFO -  at 2.9s,   estimator rf's
best error=0.0061,       best estimator lgbm's best error=0.0049
[flaml.automl.logger: 07-10 09:41:49] {2219} INFO - iteration 27, current
learner xgboost
[flaml.automl.logger: 07-10 09:41:50] {2392} INFO -  at 3.0s,   estimator
xgboost's best error=0.0054,  best estimator lgbm's best error=0.0049
[flaml.automl.logger: 07-10 09:41:50] {2219} INFO - iteration 28, current
learner xgboost
[flaml.automl.logger: 07-10 09:41:50] {2392} INFO -  at 3.1s,   estimator
xgboost's best error=0.0052,  best estimator lgbm's best error=0.0049
[flaml.automl.logger: 07-10 09:41:50] {2219} INFO - iteration 29, current
learner xgboost
[flaml.automl.logger: 07-10 09:41:50] {2392} INFO -  at 3.2s,   estimator
xgboost's best error=0.0052,  best estimator lgbm's best error=0.0049
[flaml.automl.logger: 07-10 09:41:50] {2219} INFO - iteration 30, current
learner lgbm
[flaml.automl.logger: 07-10 09:41:50] {2392} INFO -  at 3.3s,   estimator lgbm's
best error=0.0048,     best estimator lgbm's best error=0.0048
[flaml.automl.logger: 07-10 09:41:50] {2219} INFO - iteration 31, current
learner lgbm
[flaml.automl.logger: 07-10 09:41:50] {2392} INFO -  at 3.4s,   estimator lgbm's
best error=0.0048,     best estimator lgbm's best error=0.0048
[flaml.automl.logger: 07-10 09:41:50] {2219} INFO - iteration 32, current
learner lgbm
[flaml.automl.logger: 07-10 09:41:50] {2392} INFO -  at 3.5s,   estimator lgbm's
best error=0.0042,     best estimator lgbm's best error=0.0042
[flaml.automl.logger: 07-10 09:41:50] {2219} INFO - iteration 33, current
learner rf
[flaml.automl.logger: 07-10 09:41:50] {2392} INFO -  at 3.8s,   estimator rf's
best error=0.0039,       best estimator rf's best error=0.0039
[flaml.automl.logger: 07-10 09:41:50] {2219} INFO - iteration 34, current
learner lgbm
[flaml.automl.logger: 07-10 09:41:50] {2392} INFO -  at 3.9s,   estimator lgbm's
best error=0.0042,     best estimator rf's best error=0.0039
[flaml.automl.logger: 07-10 09:41:50] {2219} INFO - iteration 35, current
learner lgbm
[flaml.automl.logger: 07-10 09:41:51] {2392} INFO -  at 4.0s,   estimator lgbm's
best error=0.0042,     best estimator rf's best error=0.0039
[flaml.automl.logger: 07-10 09:41:51] {2219} INFO - iteration 36, current
learner extra_tree
[flaml.automl.logger: 07-10 09:41:51] {2392} INFO -  at 4.2s,   estimator
extra_tree's best error=0.1999,       best estimator rf's best error=0.0039
[flaml.automl.logger: 07-10 09:41:51] {2219} INFO - iteration 37, current
learner lgbm
[flaml.automl.logger: 07-10 09:41:51] {2392} INFO -  at 4.5s,   estimator lgbm's
```

```
best error=0.0042,     best estimator rf's best error=0.0039
[flaml.automl.logger: 07-10 09:41:51] {2219} INFO - iteration 38, current
learner rf
[flaml.automl.logger: 07-10 09:41:51] {2392} INFO -  at 4.8s,   estimator rf's
best error=0.0039,       best estimator rf's best error=0.0039
[flaml.automl.logger: 07-10 09:41:51] {2219} INFO - iteration 39, current
learner lgbm
[flaml.automl.logger: 07-10 09:41:52] {2392} INFO -  at 4.9s,   estimator lgbm's
best error=0.0042,     best estimator rf's best error=0.0039
[flaml.automl.logger: 07-10 09:41:52] {2219} INFO - iteration 40, current
learner rf
[flaml.automl.logger: 07-10 09:41:52] {2392} INFO -  at 5.1s,   estimator rf's
best error=0.0039,       best estimator rf's best error=0.0039
[flaml.automl.logger: 07-10 09:41:52] {2219} INFO - iteration 41, current
learner rf
[flaml.automl.logger: 07-10 09:41:52] {2392} INFO -  at 5.4s,   estimator rf's
best error=0.0039,       best estimator rf's best error=0.0039
[flaml.automl.logger: 07-10 09:41:52] {2219} INFO - iteration 42, current
learner lgbm
[flaml.automl.logger: 07-10 09:41:52] {2392} INFO -  at 5.5s,   estimator lgbm's
best error=0.0042,     best estimator rf's best error=0.0039
[flaml.automl.logger: 07-10 09:41:52] {2219} INFO - iteration 43, current
learner rf
[flaml.automl.logger: 07-10 09:41:52] {2392} INFO -  at 5.8s,   estimator rf's
best error=0.0039,       best estimator rf's best error=0.0039
[flaml.automl.logger: 07-10 09:41:52] {2219} INFO - iteration 44, current
learner extra_tree
[flaml.automl.logger: 07-10 09:41:53] {2392} INFO -  at 5.9s,   estimator
extra_tree's best error=0.1999,       best estimator rf's best error=0.0039
[flaml.automl.logger: 07-10 09:41:53] {2219} INFO - iteration 45, current
learner rf
[flaml.automl.logger: 07-10 09:41:53] {2392} INFO -  at 6.2s,   estimator rf's
best error=0.0039,       best estimator rf's best error=0.0039
[flaml.automl.logger: 07-10 09:41:53] {2219} INFO - iteration 46, current
learner lgbm
[flaml.automl.logger: 07-10 09:41:53] {2392} INFO -  at 6.3s,   estimator lgbm's
best error=0.0041,     best estimator rf's best error=0.0039
[flaml.automl.logger: 07-10 09:41:53] {2219} INFO - iteration 47, current
learner rf
[flaml.automl.logger: 07-10 09:41:53] {2392} INFO -  at 6.6s,   estimator rf's
best error=0.0039,       best estimator rf's best error=0.0039
[flaml.automl.logger: 07-10 09:41:53] {2219} INFO - iteration 48, current
learner lgbm
[flaml.automl.logger: 07-10 09:41:53] {2392} INFO -  at 6.7s,   estimator lgbm's
best error=0.0041,     best estimator rf's best error=0.0039
[flaml.automl.logger: 07-10 09:41:53] {2219} INFO - iteration 49, current
learner rf
[flaml.automl.logger: 07-10 09:41:54] {2392} INFO -  at 7.0s,   estimator rf's
```

```
best error=0.0039,       best estimator rf's best error=0.0039
[flaml.automl.logger: 07-10 09:41:54] {2219} INFO - iteration 50, current
learner extra_tree
[flaml.automl.logger: 07-10 09:41:54] {2392} INFO -  at 7.1s,   estimator
extra_tree's best error=0.1999,       best estimator rf's best error=0.0039
[flaml.automl.logger: 07-10 09:41:54] {2219} INFO - iteration 51, current
learner lgbm
[flaml.automl.logger: 07-10 09:41:54] {2392} INFO -  at 7.2s,   estimator lgbm's
best error=0.0040,     best estimator rf's best error=0.0039
[flaml.automl.logger: 07-10 09:41:54] {2219} INFO - iteration 52, current
learner lgbm
[flaml.automl.logger: 07-10 09:41:54] {2392} INFO -  at 7.3s,   estimator lgbm's
best error=0.0040,     best estimator rf's best error=0.0039
[flaml.automl.logger: 07-10 09:41:54] {2219} INFO - iteration 53, current
learner lgbm
[flaml.automl.logger: 07-10 09:41:54] {2392} INFO -  at 7.4s,   estimator lgbm's
best error=0.0040,     best estimator rf's best error=0.0039
[flaml.automl.logger: 07-10 09:41:54] {2219} INFO - iteration 54, current
learner lgbm
[flaml.automl.logger: 07-10 09:41:54] {2392} INFO -  at 7.5s,   estimator lgbm's
best error=0.0040,     best estimator rf's best error=0.0039
[flaml.automl.logger: 07-10 09:41:54] {2219} INFO - iteration 55, current
learner rf
[flaml.automl.logger: 07-10 09:41:54] {2392} INFO -  at 7.8s,   estimator rf's
best error=0.0039,       best estimator rf's best error=0.0039
[flaml.automl.logger: 07-10 09:41:54] {2219} INFO - iteration 56, current
learner lgbm
[flaml.automl.logger: 07-10 09:41:55] {2392} INFO -  at 8.0s,   estimator lgbm's
best error=0.0040,     best estimator rf's best error=0.0039
[flaml.automl.logger: 07-10 09:41:55] {2219} INFO - iteration 57, current
learner lgbm
[flaml.automl.logger: 07-10 09:41:56] {2392} INFO -  at 9.0s,   estimator lgbm's
best error=0.0040,     best estimator rf's best error=0.0039
[flaml.automl.logger: 07-10 09:41:56] {2219} INFO - iteration 58, current
learner lgbm
[flaml.automl.logger: 07-10 09:41:56] {2392} INFO -  at 9.1s,   estimator lgbm's
best error=0.0040,     best estimator rf's best error=0.0039
[flaml.automl.logger: 07-10 09:41:56] {2219} INFO - iteration 59, current
learner lgbm
[flaml.automl.logger: 07-10 09:41:56] {2392} INFO -  at 9.2s,   estimator lgbm's
best error=0.0040,     best estimator rf's best error=0.0039
[flaml.automl.logger: 07-10 09:41:56] {2219} INFO - iteration 60, current
learner lgbm
[flaml.automl.logger: 07-10 09:41:57] {2392} INFO -  at 10.1s,  estimator lgbm's
best error=0.0040,     best estimator rf's best error=0.0039
[flaml.automl.logger: 07-10 09:41:57] {2219} INFO - iteration 61, current
learner lgbm
[flaml.automl.logger: 07-10 09:41:57] {2392} INFO -  at 10.2s,  estimator lgbm's
```

```
best error=0.0040,     best estimator rf's best error=0.0039
[flaml.automl.logger: 07-10 09:41:57] {2219} INFO - iteration 62, current
learner rf
[flaml.automl.logger: 07-10 09:41:57] {2392} INFO -  at 10.6s,  estimator rf's
best error=0.0039,       best estimator rf's best error=0.0039
[flaml.automl.logger: 07-10 09:41:57] {2219} INFO - iteration 63, current
learner rf
[flaml.automl.logger: 07-10 09:41:57] {2392} INFO -  at 10.8s,  estimator rf's
best error=0.0036,       best estimator rf's best error=0.0036
[flaml.automl.logger: 07-10 09:41:57] {2219} INFO - iteration 64, current
learner rf
[flaml.automl.logger: 07-10 09:41:58] {2392} INFO -  at 11.3s,  estimator rf's
best error=0.0036,       best estimator rf's best error=0.0036
[flaml.automl.logger: 07-10 09:41:58] {2219} INFO - iteration 65, current
learner rf
[flaml.automl.logger: 07-10 09:41:58] {2392} INFO -  at 11.5s,  estimator rf's
best error=0.0036,       best estimator rf's best error=0.0036
[flaml.automl.logger: 07-10 09:41:58] {2219} INFO - iteration 66, current
learner rf
[flaml.automl.logger: 07-10 09:41:59] {2392} INFO -  at 11.9s,  estimator rf's
best error=0.0036,       best estimator rf's best error=0.0036
[flaml.automl.logger: 07-10 09:41:59] {2219} INFO - iteration 67, current
learner rf
[flaml.automl.logger: 07-10 09:41:59] {2392} INFO -  at 12.1s,  estimator rf's
best error=0.0036,       best estimator rf's best error=0.0036
[flaml.automl.logger: 07-10 09:41:59] {2219} INFO - iteration 68, current
learner lgbm
[flaml.automl.logger: 07-10 09:41:59] {2392} INFO -  at 12.5s,  estimator lgbm's
best error=0.0040,     best estimator rf's best error=0.0036
[flaml.automl.logger: 07-10 09:41:59] {2219} INFO - iteration 69, current
learner rf
[flaml.automl.logger: 07-10 09:42:00] {2392} INFO -  at 12.9s,  estimator rf's
best error=0.0036,       best estimator rf's best error=0.0036
[flaml.automl.logger: 07-10 09:42:00] {2219} INFO - iteration 70, current
learner rf
[flaml.automl.logger: 07-10 09:42:00] {2392} INFO -  at 13.1s,  estimator rf's
best error=0.0036,       best estimator rf's best error=0.0036
[flaml.automl.logger: 07-10 09:42:00] {2219} INFO - iteration 71, current
learner rf
[flaml.automl.logger: 07-10 09:42:00] {2392} INFO -  at 13.5s,  estimator rf's
best error=0.0036,       best estimator rf's best error=0.0036
[flaml.automl.logger: 07-10 09:42:00] {2219} INFO - iteration 72, current
learner extra_tree
[flaml.automl.logger: 07-10 09:42:00] {2392} INFO -  at 13.7s,  estimator
extra_tree's best error=0.0671,       best estimator rf's best error=0.0036
[flaml.automl.logger: 07-10 09:42:00] {2219} INFO - iteration 73, current
learner extra_tree
[flaml.automl.logger: 07-10 09:42:00] {2392} INFO -  at 13.9s,  estimator
```

```
extra_tree's best error=0.0473,       best estimator rf's best error=0.0036
[flaml.automl.logger: 07-10 09:42:00] {2219} INFO - iteration 74, current
learner extra_tree
[flaml.automl.logger: 07-10 09:42:01] {2392} INFO -  at 14.0s,  estimator
extra_tree's best error=0.0473,       best estimator rf's best error=0.0036
[flaml.automl.logger: 07-10 09:42:01] {2219} INFO - iteration 75, current
learner rf
[flaml.automl.logger: 07-10 09:42:01] {2392} INFO -  at 14.3s,  estimator rf's
best error=0.0036,       best estimator rf's best error=0.0036
[flaml.automl.logger: 07-10 09:42:01] {2219} INFO - iteration 76, current
learner rf
[flaml.automl.logger: 07-10 09:42:01] {2392} INFO -  at 14.5s,  estimator rf's
best error=0.0036,       best estimator rf's best error=0.0036
[flaml.automl.logger: 07-10 09:42:01] {2219} INFO - iteration 77, current
learner extra_tree
[flaml.automl.logger: 07-10 09:42:01] {2392} INFO -  at 14.7s,  estimator
extra_tree's best error=0.0473,       best estimator rf's best error=0.0036
[flaml.automl.logger: 07-10 09:42:01] {2219} INFO - iteration 78, current
learner rf
[flaml.automl.logger: 07-10 09:42:02] {2392} INFO -  at 15.2s,  estimator rf's
best error=0.0036,       best estimator rf's best error=0.0036
[flaml.automl.logger: 07-10 09:42:02] {2219} INFO - iteration 79, current
learner rf
[flaml.automl.logger: 07-10 09:42:02] {2392} INFO -  at 15.6s,  estimator rf's
best error=0.0036,       best estimator rf's best error=0.0036
[flaml.automl.logger: 07-10 09:42:02] {2219} INFO - iteration 80, current
learner extra_tree
[flaml.automl.logger: 07-10 09:42:02] {2392} INFO -  at 15.7s,  estimator
extra_tree's best error=0.0473,       best estimator rf's best error=0.0036
[flaml.automl.logger: 07-10 09:42:02] {2219} INFO - iteration 81, current
learner rf
[flaml.automl.logger: 07-10 09:42:03] {2392} INFO -  at 16.0s,  estimator rf's
best error=0.0036,       best estimator rf's best error=0.0036
[flaml.automl.logger: 07-10 09:42:03] {2219} INFO - iteration 82, current
learner extra_tree
[flaml.automl.logger: 07-10 09:42:03] {2392} INFO -  at 16.2s,  estimator
extra_tree's best error=0.0242,       best estimator rf's best error=0.0036
[flaml.automl.logger: 07-10 09:42:03] {2219} INFO - iteration 83, current
learner extra_tree
[flaml.automl.logger: 07-10 09:42:03] {2392} INFO -  at 16.4s,  estimator
extra_tree's best error=0.0242,       best estimator rf's best error=0.0036
[flaml.automl.logger: 07-10 09:42:03] {2219} INFO - iteration 84, current
learner extra_tree
[flaml.automl.logger: 07-10 09:42:03] {2392} INFO -  at 16.6s,  estimator
extra_tree's best error=0.0242,       best estimator rf's best error=0.0036
[flaml.automl.logger: 07-10 09:42:03] {2219} INFO - iteration 85, current
learner extra_tree
[flaml.automl.logger: 07-10 09:42:03] {2392} INFO -  at 16.9s,  estimator
```

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extra_tree's best error=0.0242,       best estimator rf's best error=0.0036
[flaml.automl.logger: 07-10 09:42:03] {2219} INFO - iteration 86, current
learner extra_tree
[flaml.automl.logger: 07-10 09:42:04] {2392} INFO -  at 17.1s,  estimator
extra_tree's best error=0.0242,       best estimator rf's best error=0.0036
[flaml.automl.logger: 07-10 09:42:04] {2219} INFO - iteration 87, current
learner rf
[flaml.automl.logger: 07-10 09:42:04] {2392} INFO -  at 17.3s,  estimator rf's
best error=0.0036,       best estimator rf's best error=0.0036
[flaml.automl.logger: 07-10 09:42:04] {2219} INFO - iteration 88, current
learner rf
[flaml.automl.logger: 07-10 09:42:04] {2392} INFO -  at 17.8s,  estimator rf's
best error=0.0036,       best estimator rf's best error=0.0036
[flaml.automl.logger: 07-10 09:42:04] {2219} INFO - iteration 89, current
learner extra_tree
[flaml.automl.logger: 07-10 09:42:05] {2392} INFO -  at 18.0s,  estimator
extra_tree's best error=0.0093,       best estimator rf's best error=0.0036
[flaml.automl.logger: 07-10 09:42:05] {2219} INFO - iteration 90, current
learner extra_tree
[flaml.automl.logger: 07-10 09:42:05] {2392} INFO -  at 18.3s,  estimator
extra_tree's best error=0.0093,       best estimator rf's best error=0.0036
[flaml.automl.logger: 07-10 09:42:05] {2219} INFO - iteration 91, current
learner extra_tree
[flaml.automl.logger: 07-10 09:42:05] {2392} INFO -  at 18.5s,  estimator
extra_tree's best error=0.0093,       best estimator rf's best error=0.0036
[flaml.automl.logger: 07-10 09:42:05] {2219} INFO - iteration 92, current
learner extra_tree
[flaml.automl.logger: 07-10 09:42:05] {2392} INFO -  at 18.8s,  estimator
extra_tree's best error=0.0093,       best estimator rf's best error=0.0036
[flaml.automl.logger: 07-10 09:42:05] {2219} INFO - iteration 93, current
learner extra_tree
[flaml.automl.logger: 07-10 09:42:06] {2392} INFO -  at 19.0s,  estimator
extra_tree's best error=0.0090,       best estimator rf's best error=0.0036
[flaml.automl.logger: 07-10 09:42:06] {2219} INFO - iteration 94, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:06] {2392} INFO -  at 19.1s,  estimator
xgb_limitdepth's best error=0.0045,   best estimator rf's best error=0.0036
[flaml.automl.logger: 07-10 09:42:06] {2219} INFO - iteration 95, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:06] {2392} INFO -  at 19.2s,  estimator
xgb_limitdepth's best error=0.0041,   best estimator rf's best error=0.0036
[flaml.automl.logger: 07-10 09:42:06] {2219} INFO - iteration 96, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:06] {2392} INFO -  at 19.4s,  estimator
xgb_limitdepth's best error=0.0041,   best estimator rf's best error=0.0036
[flaml.automl.logger: 07-10 09:42:06] {2219} INFO - iteration 97, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:06] {2392} INFO -  at 19.4s,  estimator
```

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xgb_limitdepth's best error=0.0041,   best estimator rf's best error=0.0036
[flaml.automl.logger: 07-10 09:42:06] {2219} INFO - iteration 98, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:06] {2392} INFO -  at 19.7s,  estimator
xgb_limitdepth's best error=0.0041,   best estimator rf's best error=0.0036
[flaml.automl.logger: 07-10 09:42:06] {2219} INFO - iteration 99, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:06] {2392} INFO -  at 19.8s,  estimator
xgb_limitdepth's best error=0.0038,   best estimator rf's best error=0.0036
[flaml.automl.logger: 07-10 09:42:06] {2219} INFO - iteration 100, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:07] {2392} INFO -  at 19.9s,  estimator
xgb_limitdepth's best error=0.0038,   best estimator rf's best error=0.0036
[flaml.automl.logger: 07-10 09:42:07] {2219} INFO - iteration 101, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:07] {2392} INFO -  at 20.0s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:07] {2219} INFO - iteration 102, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:07] {2392} INFO -  at 20.1s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:07] {2219} INFO - iteration 103, current
learner lgbm
[flaml.automl.logger: 07-10 09:42:07] {2392} INFO -  at 20.2s,  estimator lgbm's
best error=0.0040,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:07] {2219} INFO - iteration 104, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:07] {2392} INFO -  at 20.4s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:07] {2219} INFO - iteration 105, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:07] {2392} INFO -  at 20.5s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:07] {2219} INFO - iteration 106, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:07] {2392} INFO -  at 20.6s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:07] {2219} INFO - iteration 107, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:07] {2392} INFO -  at 20.9s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:07] {2219} INFO - iteration 108, current
```

```
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:08] {2392} INFO -  at 21.0s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:08] {2219} INFO - iteration 109, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:08] {2392} INFO -  at 21.2s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:08] {2219} INFO - iteration 110, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:08] {2392} INFO -  at 21.3s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:08] {2219} INFO - iteration 111, current
learner lgbm
[flaml.automl.logger: 07-10 09:42:09] {2392} INFO -  at 22.3s,  estimator lgbm's
best error=0.0040,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:09] {2219} INFO - iteration 112, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:09] {2392} INFO -  at 22.5s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:09] {2219} INFO - iteration 113, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:09] {2392} INFO -  at 22.6s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:09] {2219} INFO - iteration 114, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:09] {2392} INFO -  at 22.7s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:09] {2219} INFO - iteration 115, current
learner rf
[flaml.automl.logger: 07-10 09:42:10] {2392} INFO -  at 22.9s,  estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:10] {2219} INFO - iteration 116, current
learner rf
[flaml.automl.logger: 07-10 09:42:10] {2392} INFO -  at 23.4s,  estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:10] {2219} INFO - iteration 117, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:10] {2392} INFO -  at 23.5s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:10] {2219} INFO - iteration 118, current
learner xgb_limitdepth
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[flaml.automl.logger: 07-10 09:42:10] {2392} INFO -  at 23.6s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:10] {2219} INFO - iteration 119, current
learner rf
[flaml.automl.logger: 07-10 09:42:11] {2392} INFO -  at 24.1s,  estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:11] {2219} INFO - iteration 120, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:11] {2392} INFO -  at 24.2s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:11] {2219} INFO - iteration 121, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:11] {2392} INFO -  at 24.3s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:11] {2219} INFO - iteration 122, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:11] {2392} INFO -  at 24.4s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:11] {2219} INFO - iteration 123, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:11] {2392} INFO -  at 24.5s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:11] {2219} INFO - iteration 124, current
learner rf
[flaml.automl.logger: 07-10 09:42:11] {2392} INFO -  at 24.8s,  estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:11] {2219} INFO - iteration 125, current
learner lgbm
[flaml.automl.logger: 07-10 09:42:12] {2392} INFO -  at 25.5s,  estimator lgbm's
best error=0.0039,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:12] {2219} INFO - iteration 126, current
learner rf
[flaml.automl.logger: 07-10 09:42:12] {2392} INFO -  at 25.9s,  estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:12] {2219} INFO - iteration 127, current
learner rf
[flaml.automl.logger: 07-10 09:42:13] {2392} INFO -  at 26.2s,  estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:13] {2219} INFO - iteration 128, current
learner xgboost
[flaml.automl.logger: 07-10 09:42:13] {2392} INFO -  at 26.3s,  estimator
xgboost's best error=0.0052,  best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:13] {2219} INFO - iteration 129, current
```

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learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:13] {2392} INFO -  at 26.5s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:13] {2219} INFO - iteration 130, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:13] {2392} INFO -  at 26.6s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:13] {2219} INFO - iteration 131, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:13] {2392} INFO -  at 26.7s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:13] {2219} INFO - iteration 132, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:13] {2392} INFO -  at 26.8s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:13] {2219} INFO - iteration 133, current
learner rf
[flaml.automl.logger: 07-10 09:42:14] {2392} INFO -  at 27.1s,  estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:14] {2219} INFO - iteration 134, current
learner xgboost
[flaml.automl.logger: 07-10 09:42:14] {2392} INFO -  at 27.2s,  estimator
xgboost's best error=0.0052,  best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:14] {2219} INFO - iteration 135, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:14] {2392} INFO -  at 27.3s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:14] {2219} INFO - iteration 136, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:14] {2392} INFO -  at 27.4s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:14] {2219} INFO - iteration 137, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:14] {2392} INFO -  at 27.5s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:14] {2219} INFO - iteration 138, current
learner lgbm
[flaml.automl.logger: 07-10 09:42:14] {2392} INFO -  at 27.8s,  estimator lgbm's
best error=0.0039,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:14] {2219} INFO - iteration 139, current
learner xgb_limitdepth
```

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[flaml.automl.logger: 07-10 09:42:15] {2392} INFO -  at 28.0s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:15] {2219} INFO - iteration 140, current
learner lgbm
[flaml.automl.logger: 07-10 09:42:15] {2392} INFO -  at 28.3s,  estimator lgbm's
best error=0.0039,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:15] {2219} INFO - iteration 141, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:15] {2392} INFO -  at 28.5s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:15] {2219} INFO - iteration 142, current
learner rf
[flaml.automl.logger: 07-10 09:42:15] {2392} INFO -  at 28.7s,  estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:15] {2219} INFO - iteration 143, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:15] {2392} INFO -  at 28.8s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:15] {2219} INFO - iteration 144, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:16] {2392} INFO -  at 28.9s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:16] {2219} INFO - iteration 145, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:16] {2392} INFO -  at 29.0s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:16] {2219} INFO - iteration 146, current
learner lgbm
[flaml.automl.logger: 07-10 09:42:16] {2392} INFO -  at 29.3s,  estimator lgbm's
best error=0.0037,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:16] {2219} INFO - iteration 147, current
learner lgbm
[flaml.automl.logger: 07-10 09:42:16] {2392} INFO -  at 29.5s,  estimator lgbm's
best error=0.0037,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:16] {2219} INFO - iteration 148, current
learner lgbm
[flaml.automl.logger: 07-10 09:42:16] {2392} INFO -  at 29.7s,  estimator lgbm's
best error=0.0037,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:16] {2219} INFO - iteration 149, current
learner lgbm
[flaml.automl.logger: 07-10 09:42:16] {2392} INFO -  at 29.8s,  estimator lgbm's
best error=0.0037,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:16] {2219} INFO - iteration 150, current
```

```
learner lgbm
[flaml.automl.logger: 07-10 09:42:17] {2392} INFO -  at 30.1s,  estimator lgbm's
best error=0.0037,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:17] {2219} INFO - iteration 151, current
learner lgbm
[flaml.automl.logger: 07-10 09:42:17] {2392} INFO -  at 30.6s,  estimator lgbm's
best error=0.0036,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:17] {2219} INFO - iteration 152, current
learner rf
[flaml.automl.logger: 07-10 09:42:18] {2392} INFO -  at 31.0s,  estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:18] {2219} INFO - iteration 153, current
learner lgbm
[flaml.automl.logger: 07-10 09:42:19] {2392} INFO -  at 32.8s,  estimator lgbm's
best error=0.0036,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:19] {2219} INFO - iteration 154, current
learner lgbm
[flaml.automl.logger: 07-10 09:42:20] {2392} INFO -  at 33.0s,  estimator lgbm's
best error=0.0036,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:20] {2219} INFO - iteration 155, current
learner lgbm
[flaml.automl.logger: 07-10 09:42:21] {2392} INFO -  at 34.7s,  estimator lgbm's
best error=0.0036,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:21] {2219} INFO - iteration 156, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:21] {2392} INFO -  at 34.8s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:21] {2219} INFO - iteration 157, current
learner rf
[flaml.automl.logger: 07-10 09:42:22] {2392} INFO -  at 35.1s,  estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:22] {2219} INFO - iteration 158, current
learner lgbm
[flaml.automl.logger: 07-10 09:42:22] {2392} INFO -  at 35.4s,  estimator lgbm's
best error=0.0036,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:22] {2219} INFO - iteration 159, current
learner lgbm
[flaml.automl.logger: 07-10 09:42:23] {2392} INFO -  at 36.6s,  estimator lgbm's
best error=0.0036,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:23] {2219} INFO - iteration 160, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:23] {2392} INFO -  at 36.8s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:23] {2219} INFO - iteration 161, current
learner lgbm
[flaml.automl.logger: 07-10 09:42:24] {2392} INFO -  at 37.1s,  estimator lgbm's
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```
best error=0.0036,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:24] {2219} INFO - iteration 162, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:24] {2392} INFO -  at 37.2s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:24] {2219} INFO - iteration 163, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:24] {2392} INFO -  at 37.4s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:24] {2219} INFO - iteration 164, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:24] {2392} INFO -  at 37.6s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:24] {2219} INFO - iteration 165, current
learner lgbm
[flaml.automl.logger: 07-10 09:42:25] {2392} INFO -  at 38.4s,  estimator lgbm's
best error=0.0036,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:25] {2219} INFO - iteration 166, current
learner rf
[flaml.automl.logger: 07-10 09:42:25] {2392} INFO -  at 38.7s,  estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:25] {2219} INFO - iteration 167, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:25] {2392} INFO -  at 38.8s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:25] {2219} INFO - iteration 168, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:26] {2392} INFO -  at 38.9s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:26] {2219} INFO - iteration 169, current
learner lgbm
[flaml.automl.logger: 07-10 09:42:26] {2392} INFO -  at 39.3s,  estimator lgbm's
best error=0.0036,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:26] {2219} INFO - iteration 170, current
learner lgbm
[flaml.automl.logger: 07-10 09:42:26] {2392} INFO -  at 39.8s,  estimator lgbm's
best error=0.0036,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:26] {2219} INFO - iteration 171, current
learner lgbm
[flaml.automl.logger: 07-10 09:42:27] {2392} INFO -  at 40.6s,  estimator lgbm's
best error=0.0036,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:27] {2219} INFO - iteration 172, current
learner rf
```

```
[flaml.automl.logger: 07-10 09:42:28] {2392} INFO -  at 41.0s,  estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:28] {2219} INFO - iteration 173, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:28] {2392} INFO -  at 41.1s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:28] {2219} INFO - iteration 174, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:28] {2392} INFO -  at 41.2s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:28] {2219} INFO - iteration 175, current
learner rf
[flaml.automl.logger: 07-10 09:42:28] {2392} INFO -  at 41.5s,  estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:28] {2219} INFO - iteration 176, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:28] {2392} INFO -  at 41.6s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:28] {2219} INFO - iteration 177, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:28] {2392} INFO -  at 41.8s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:28] {2219} INFO - iteration 178, current
learner rf
[flaml.automl.logger: 07-10 09:42:29] {2392} INFO -  at 42.0s,  estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:29] {2219} INFO - iteration 179, current
learner extra_tree
[flaml.automl.logger: 07-10 09:42:29] {2392} INFO -  at 42.2s,  estimator
extra_tree's best error=0.0069,       best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:29] {2219} INFO - iteration 180, current
learner extra_tree
[flaml.automl.logger: 07-10 09:42:29] {2392} INFO -  at 42.5s,  estimator
extra_tree's best error=0.0069,       best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:29] {2219} INFO - iteration 181, current
learner extra_tree
[flaml.automl.logger: 07-10 09:42:29] {2392} INFO -  at 42.7s,  estimator
extra_tree's best error=0.0069,       best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:29] {2219} INFO - iteration 182, current
learner extra_tree
[flaml.automl.logger: 07-10 09:42:29] {2392} INFO -  at 42.9s,  estimator
```

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extra_tree's best error=0.0069,       best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:29] {2219} INFO - iteration 183, current
learner lgbm
[flaml.automl.logger: 07-10 09:42:31] {2392} INFO -  at 44.8s,  estimator lgbm's
best error=0.0036,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:31] {2219} INFO - iteration 184, current
learner extra_tree
[flaml.automl.logger: 07-10 09:42:32] {2392} INFO -  at 45.0s,  estimator
extra_tree's best error=0.0069,       best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:32] {2219} INFO - iteration 185, current
learner extra_tree
[flaml.automl.logger: 07-10 09:42:32] {2392} INFO -  at 45.3s,  estimator
extra_tree's best error=0.0069,       best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:32] {2219} INFO - iteration 186, current
learner rf
[flaml.automl.logger: 07-10 09:42:32] {2392} INFO -  at 45.7s,  estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:32] {2219} INFO - iteration 187, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:32] {2392} INFO -  at 45.8s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:32] {2219} INFO - iteration 188, current
learner lgbm
[flaml.automl.logger: 07-10 09:42:33] {2392} INFO -  at 46.1s,  estimator lgbm's
best error=0.0036,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:33] {2219} INFO - iteration 189, current
learner rf
[flaml.automl.logger: 07-10 09:42:33] {2392} INFO -  at 46.4s,  estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:33] {2219} INFO - iteration 190, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:33] {2392} INFO -  at 46.5s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:33] {2219} INFO - iteration 191, current
learner rf
[flaml.automl.logger: 07-10 09:42:33] {2392} INFO -  at 46.9s,  estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:33] {2219} INFO - iteration 192, current
learner extra_tree
[flaml.automl.logger: 07-10 09:42:34] {2392} INFO -  at 47.1s,  estimator
extra_tree's best error=0.0069,       best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:34] {2219} INFO - iteration 193, current
```

```
learner extra_tree
[flaml.automl.logger: 07-10 09:42:34] {2392} INFO -  at 47.3s,  estimator
extra_tree's best error=0.0069,       best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:34] {2219} INFO - iteration 194, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:34] {2392} INFO -  at 47.4s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:34] {2219} INFO - iteration 195, current
learner rf
[flaml.automl.logger: 07-10 09:42:34] {2392} INFO -  at 47.6s,  estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:34] {2219} INFO - iteration 196, current
learner lgbm
[flaml.automl.logger: 07-10 09:42:35] {2392} INFO -  at 48.5s,  estimator lgbm's
best error=0.0036,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:35] {2219} INFO - iteration 197, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:35] {2392} INFO -  at 48.6s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:35] {2219} INFO - iteration 198, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:35] {2392} INFO -  at 48.8s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:35] {2219} INFO - iteration 199, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:36] {2392} INFO -  at 48.9s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:36] {2219} INFO - iteration 200, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:36] {2392} INFO -  at 49.0s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:36] {2219} INFO - iteration 201, current
learner lgbm
[flaml.automl.logger: 07-10 09:42:36] {2392} INFO -  at 49.3s,  estimator lgbm's
best error=0.0036,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:36] {2219} INFO - iteration 202, current
learner rf
[flaml.automl.logger: 07-10 09:42:36] {2392} INFO -  at 49.6s,  estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:36] {2219} INFO - iteration 203, current
learner extra_tree
[flaml.automl.logger: 07-10 09:42:36] {2392} INFO -  at 49.8s,  estimator
```

```
extra_tree's best error=0.0069,       best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:36] {2219} INFO - iteration 204, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:37] {2392} INFO -  at 49.9s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:37] {2219} INFO - iteration 205, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:37] {2392} INFO -  at 50.0s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:37] {2219} INFO - iteration 206, current
learner extra_tree
[flaml.automl.logger: 07-10 09:42:37] {2392} INFO -  at 50.3s,  estimator
extra_tree's best error=0.0069,       best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:37] {2219} INFO - iteration 207, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:37] {2392} INFO -  at 50.4s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:37] {2219} INFO - iteration 208, current
learner extra_tree
[flaml.automl.logger: 07-10 09:42:37] {2392} INFO -  at 50.6s,  estimator
extra_tree's best error=0.0069,       best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:37] {2219} INFO - iteration 209, current
learner extra_tree
[flaml.automl.logger: 07-10 09:42:38] {2392} INFO -  at 50.9s,  estimator
extra_tree's best error=0.0058,       best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:38] {2219} INFO - iteration 210, current
learner extra_tree
[flaml.automl.logger: 07-10 09:42:38] {2392} INFO -  at 51.8s,  estimator
extra_tree's best error=0.0056,       best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:38] {2219} INFO - iteration 211, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:39] {2392} INFO -  at 52.0s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:39] {2219} INFO - iteration 212, current
learner extra_tree
[flaml.automl.logger: 07-10 09:42:39] {2392} INFO -  at 52.2s,  estimator
extra_tree's best error=0.0056,       best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:39] {2219} INFO - iteration 213, current
```

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learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:39] {2392} INFO -  at 52.4s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:39] {2219} INFO - iteration 214, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:39] {2392} INFO -  at 52.5s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:39] {2219} INFO - iteration 215, current
learner rf
[flaml.automl.logger: 07-10 09:42:39] {2392} INFO -  at 52.9s,  estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:39] {2219} INFO - iteration 216, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:40] {2392} INFO -  at 53.0s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:40] {2219} INFO - iteration 217, current
learner lgbm
[flaml.automl.logger: 07-10 09:42:40] {2392} INFO -  at 53.7s,  estimator lgbm's
best error=0.0036,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:40] {2219} INFO - iteration 218, current
learner lgbm
[flaml.automl.logger: 07-10 09:42:41] {2392} INFO -  at 54.1s,  estimator lgbm's
best error=0.0036,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:41] {2219} INFO - iteration 219, current
learner lgbm
[flaml.automl.logger: 07-10 09:42:41] {2392} INFO -  at 54.4s,  estimator lgbm's
best error=0.0036,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:41] {2219} INFO - iteration 220, current
learner extra_tree
[flaml.automl.logger: 07-10 09:42:42] {2392} INFO -  at 54.9s,  estimator
extra_tree's best error=0.0056,       best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:42] {2219} INFO - iteration 221, current
learner lgbm
[flaml.automl.logger: 07-10 09:42:42] {2392} INFO -  at 55.7s,  estimator lgbm's
best error=0.0036,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:42] {2219} INFO - iteration 222, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:43] {2392} INFO -  at 56.0s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:43] {2219} INFO - iteration 223, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:43] {2392} INFO -  at 56.1s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
```

```
error=0.0036
[flaml.automl.logger: 07-10 09:42:43] {2219} INFO - iteration 224, current
learner lgbm
[flaml.automl.logger: 07-10 09:42:43] {2392} INFO -  at 56.4s,  estimator lgbm's
best error=0.0036,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:43] {2219} INFO - iteration 225, current
learner lgbm
[flaml.automl.logger: 07-10 09:42:44] {2392} INFO -  at 57.5s,  estimator lgbm's
best error=0.0036,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:44] {2219} INFO - iteration 226, current
learner rf
[flaml.automl.logger: 07-10 09:42:44] {2392} INFO -  at 57.8s,  estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:44] {2219} INFO - iteration 227, current
learner lgbm
[flaml.automl.logger: 07-10 09:42:45] {2392} INFO -  at 58.8s,  estimator lgbm's
best error=0.0036,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:45] {2219} INFO - iteration 228, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:46] {2392} INFO -  at 59.1s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:46] {2219} INFO - iteration 229, current
learner rf
[flaml.automl.logger: 07-10 09:42:46] {2392} INFO -  at 59.4s,  estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:46] {2219} INFO - iteration 230, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:46] {2392} INFO -  at 59.5s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:46] {2219} INFO - iteration 231, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:46] {2392} INFO -  at 59.6s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:46] {2219} INFO - iteration 232, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:46] {2392} INFO -  at 59.8s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:46] {2219} INFO - iteration 233, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:47] {2392} INFO -  at 59.9s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:47] {2219} INFO - iteration 234, current
learner xgb_limitdepth
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[flaml.automl.logger: 07-10 09:42:47] {2392} INFO -  at 60.1s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:47] {2219} INFO - iteration 235, current
learner rf
[flaml.automl.logger: 07-10 09:42:47] {2392} INFO -  at 60.5s,  estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:47] {2219} INFO - iteration 236, current
learner extra_tree
[flaml.automl.logger: 07-10 09:42:49] {2392} INFO -  at 62.3s,  estimator
extra_tree's best error=0.0056,       best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:49] {2219} INFO - iteration 237, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:49] {2392} INFO -  at 62.4s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:49] {2219} INFO - iteration 238, current
learner rf
[flaml.automl.logger: 07-10 09:42:49] {2392} INFO -  at 62.7s,  estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:49] {2219} INFO - iteration 239, current
learner rf
[flaml.automl.logger: 07-10 09:42:50] {2392} INFO -  at 63.0s,  estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:50] {2219} INFO - iteration 240, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:50] {2392} INFO -  at 63.2s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:50] {2219} INFO - iteration 241, current
learner lgbm
[flaml.automl.logger: 07-10 09:42:50] {2392} INFO -  at 63.6s,  estimator lgbm's
best error=0.0036,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:50] {2219} INFO - iteration 242, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:50] {2392} INFO -  at 63.8s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:50] {2219} INFO - iteration 243, current
learner rf
[flaml.automl.logger: 07-10 09:42:51] {2392} INFO -  at 64.1s,  estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:51] {2219} INFO - iteration 244, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:51] {2392} INFO -  at 64.1s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
```

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[flaml.automl.logger: 07-10 09:42:51] {2219} INFO - iteration 245, current
learner rf
[flaml.automl.logger: 07-10 09:42:51] {2392} INFO -  at 64.4s,  estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:51] {2219} INFO - iteration 246, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:51] {2392} INFO -  at 64.6s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:51] {2219} INFO - iteration 247, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:51] {2392} INFO -  at 64.7s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:51] {2219} INFO - iteration 248, current
learner lgbm
[flaml.automl.logger: 07-10 09:42:51] {2392} INFO -  at 64.9s,  estimator lgbm's
best error=0.0036,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:51] {2219} INFO - iteration 249, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:52] {2392} INFO -  at 65.2s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:52] {2219} INFO - iteration 250, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:52] {2392} INFO -  at 65.3s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:52] {2219} INFO - iteration 251, current
learner lgbm
[flaml.automl.logger: 07-10 09:42:54] {2392} INFO -  at 67.0s,  estimator lgbm's
best error=0.0036,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:54] {2219} INFO - iteration 252, current
learner rf
[flaml.automl.logger: 07-10 09:42:54] {2392} INFO -  at 67.4s,  estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:54] {2219} INFO - iteration 253, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:54] {2392} INFO -  at 67.6s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:54] {2219} INFO - iteration 254, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:54] {2392} INFO -  at 67.7s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:54] {2219} INFO - iteration 255, current
learner lgbm
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[flaml.automl.logger: 07-10 09:42:55] {2392} INFO -  at 68.1s,  estimator lgbm's
best error=0.0036,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:55] {2219} INFO - iteration 256, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:55] {2392} INFO -  at 68.2s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:55] {2219} INFO - iteration 257, current
learner rf
[flaml.automl.logger: 07-10 09:42:55] {2392} INFO -  at 68.6s,  estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:55] {2219} INFO - iteration 258, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:55] {2392} INFO -  at 68.6s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:55] {2219} INFO - iteration 259, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:55] {2392} INFO -  at 68.8s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:55] {2219} INFO - iteration 260, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:56] {2392} INFO -  at 69.0s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:56] {2219} INFO - iteration 261, current
learner extra_tree
[flaml.automl.logger: 07-10 09:42:57] {2392} INFO -  at 70.4s,  estimator
extra_tree's best error=0.0056,       best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:57] {2219} INFO - iteration 262, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:57] {2392} INFO -  at 70.5s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:57] {2219} INFO - iteration 263, current
learner rf
[flaml.automl.logger: 07-10 09:42:57] {2392} INFO -  at 70.8s,  estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:57] {2219} INFO - iteration 264, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:42:58] {2392} INFO -  at 71.0s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:42:58] {2219} INFO - iteration 265, current
learner lrl1
[flaml.automl.logger: 07-10 09:42:58] {2392} INFO -  at 71.3s,  estimator lrl1's
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best error=0.0724,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:58] {2219} INFO - iteration 266, current
learner lrl1
[flaml.automl.logger: 07-10 09:42:58] {2392} INFO -  at 71.6s,  estimator lrl1's
best error=0.0724,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:58] {2219} INFO - iteration 267, current
learner lrl1
[flaml.automl.logger: 07-10 09:42:59] {2392} INFO -  at 72.0s,  estimator lrl1's
best error=0.0523,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:59] {2219} INFO - iteration 268, current
learner lrl1
[flaml.automl.logger: 07-10 09:42:59] {2392} INFO -  at 72.3s,  estimator lrl1's
best error=0.0523,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:59] {2219} INFO - iteration 269, current
learner lrl1
[flaml.automl.logger: 07-10 09:42:59] {2392} INFO -  at 72.7s,  estimator lrl1's
best error=0.0474,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:42:59] {2219} INFO - iteration 270, current
learner lrl1
[flaml.automl.logger: 07-10 09:43:00] {2392} INFO -  at 73.1s,  estimator lrl1's
best error=0.0474,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:00] {2219} INFO - iteration 271, current
learner rf
[flaml.automl.logger: 07-10 09:43:00] {2392} INFO -  at 73.4s,  estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:00] {2219} INFO - iteration 272, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:00] {2392} INFO -  at 73.5s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:43:00] {2219} INFO - iteration 273, current
learner xgboost
[flaml.automl.logger: 07-10 09:43:01] {2392} INFO -  at 74.0s,  estimator
xgboost's best error=0.0047,  best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:01] {2219} INFO - iteration 274, current
learner xgboost
[flaml.automl.logger: 07-10 09:43:01] {2392} INFO -  at 74.1s,  estimator
xgboost's best error=0.0045,  best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:01] {2219} INFO - iteration 275, current
learner xgboost
[flaml.automl.logger: 07-10 09:43:01] {2392} INFO -  at 74.6s,  estimator
xgboost's best error=0.0045,  best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:01] {2219} INFO - iteration 276, current
learner xgboost
[flaml.automl.logger: 07-10 09:43:01] {2392} INFO -  at 74.8s,  estimator
xgboost's best error=0.0045,  best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:01] {2219} INFO - iteration 277, current
learner rf
```

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[flaml.automl.logger: 07-10 09:43:02] {2392} INFO -  at 75.2s,  estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:02] {2219} INFO - iteration 278, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:02] {2392} INFO -  at 75.3s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:43:02] {2219} INFO - iteration 279, current
learner xgboost
[flaml.automl.logger: 07-10 09:43:02] {2392} INFO -  at 75.4s,  estimator
xgboost's best error=0.0045,  best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:02] {2219} INFO - iteration 280, current
learner lrl1
[flaml.automl.logger: 07-10 09:43:02] {2392} INFO -  at 75.8s,  estimator lrl1's
best error=0.0471,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:02] {2219} INFO - iteration 281, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:02] {2392} INFO -  at 75.9s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:43:02] {2219} INFO - iteration 282, current
learner rf
[flaml.automl.logger: 07-10 09:43:03] {2392} INFO -  at 76.3s,  estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:03] {2219} INFO - iteration 283, current
learner rf
[flaml.automl.logger: 07-10 09:43:03] {2392} INFO -  at 76.6s,  estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:03] {2219} INFO - iteration 284, current
learner rf
[flaml.automl.logger: 07-10 09:43:03] {2392} INFO -  at 76.8s,  estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:03] {2219} INFO - iteration 285, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:04] {2392} INFO -  at 77.0s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:43:04] {2219} INFO - iteration 286, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:04] {2392} INFO -  at 77.1s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:43:04] {2219} INFO - iteration 287, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:04] {2392} INFO -  at 77.2s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:43:04] {2219} INFO - iteration 288, current
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learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:04] {2392} INFO -  at 77.4s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:43:04] {2219} INFO - iteration 289, current
learner rf
[flaml.automl.logger: 07-10 09:43:05] {2392} INFO -  at 77.9s,  estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:05] {2219} INFO - iteration 290, current
learner rf
[flaml.automl.logger: 07-10 09:43:05] {2392} INFO -  at 78.2s,  estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:05] {2219} INFO - iteration 291, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:05] {2392} INFO -  at 78.2s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:43:05] {2219} INFO - iteration 292, current
learner xgboost
[flaml.automl.logger: 07-10 09:43:05] {2392} INFO -  at 78.5s,  estimator
xgboost's best error=0.0045,  best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:05] {2219} INFO - iteration 293, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:05] {2392} INFO -  at 78.6s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:43:05] {2219} INFO - iteration 294, current
learner xgboost
[flaml.automl.logger: 07-10 09:43:05] {2392} INFO -  at 78.8s,  estimator
xgboost's best error=0.0045,  best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:05] {2219} INFO - iteration 295, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:06] {2392} INFO -  at 78.9s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:43:06] {2219} INFO - iteration 296, current
learner xgboost
[flaml.automl.logger: 07-10 09:43:06] {2392} INFO -  at 79.1s,  estimator
xgboost's best error=0.0045,  best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:06] {2219} INFO - iteration 297, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:06] {2392} INFO -  at 79.3s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:43:06] {2219} INFO - iteration 298, current
learner xgboost
[flaml.automl.logger: 07-10 09:43:06] {2392} INFO -  at 79.4s,  estimator
xgboost's best error=0.0045,  best estimator xgb_limitdepth's best error=0.0036
```

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[flaml.automl.logger: 07-10 09:43:06] {2219} INFO - iteration 299, current
learner rf
[flaml.automl.logger: 07-10 09:43:06] {2392} INFO -  at 79.8s,  estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:06] {2219} INFO - iteration 300, current
learner rf
[flaml.automl.logger: 07-10 09:43:07] {2392} INFO -  at 80.1s,  estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:07] {2219} INFO - iteration 301, current
learner lgbm
[flaml.automl.logger: 07-10 09:43:07] {2392} INFO -  at 80.9s,  estimator lgbm's
best error=0.0036,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:07] {2219} INFO - iteration 302, current
learner rf
[flaml.automl.logger: 07-10 09:43:08] {2392} INFO -  at 81.2s,  estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:08] {2219} INFO - iteration 303, current
learner lgbm
[flaml.automl.logger: 07-10 09:43:09] {2392} INFO -  at 82.4s,  estimator lgbm's
best error=0.0036,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:09] {2219} INFO - iteration 304, current
learner lrl1
[flaml.automl.logger: 07-10 09:43:10] {2392} INFO -  at 82.9s,  estimator lrl1's
best error=0.0471,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:10] {2219} INFO - iteration 305, current
learner lgbm
[flaml.automl.logger: 07-10 09:43:10] {2392} INFO -  at 83.3s,  estimator lgbm's
best error=0.0036,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:10] {2219} INFO - iteration 306, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:10] {2392} INFO -  at 83.5s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:43:10] {2219} INFO - iteration 307, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:10] {2392} INFO -  at 83.7s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:43:10] {2219} INFO - iteration 308, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:10] {2392} INFO -  at 83.8s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:43:10] {2219} INFO - iteration 309, current
learner xgboost
[flaml.automl.logger: 07-10 09:43:11] {2392} INFO -  at 84.1s,  estimator
xgboost's best error=0.0045,  best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:11] {2219} INFO - iteration 310, current
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learner lgbm
[flaml.automl.logger: 07-10 09:43:11] {2392} INFO -  at 84.7s,  estimator lgbm's
best error=0.0036,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:11] {2219} INFO - iteration 311, current
learner xgboost
[flaml.automl.logger: 07-10 09:43:12] {2392} INFO -  at 84.9s,  estimator
xgboost's best error=0.0045,  best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:12] {2219} INFO - iteration 312, current
learner rf
[flaml.automl.logger: 07-10 09:43:12] {2392} INFO -  at 85.3s,  estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:12] {2219} INFO - iteration 313, current
learner rf
[flaml.automl.logger: 07-10 09:43:12] {2392} INFO -  at 85.6s,  estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:12] {2219} INFO - iteration 314, current
learner extra_tree
[flaml.automl.logger: 07-10 09:43:13] {2392} INFO -  at 86.1s,  estimator
extra_tree's best error=0.0055,       best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:43:13] {2219} INFO - iteration 315, current
learner rf
[flaml.automl.logger: 07-10 09:43:13] {2392} INFO -  at 86.5s,  estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:13] {2219} INFO - iteration 316, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:13] {2392} INFO -  at 86.8s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:43:13] {2219} INFO - iteration 317, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:13] {2392} INFO -  at 86.9s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:43:14] {2219} INFO - iteration 318, current
learner rf
[flaml.automl.logger: 07-10 09:43:14] {2392} INFO -  at 87.1s,  estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:14] {2219} INFO - iteration 319, current
learner lgbm
[flaml.automl.logger: 07-10 09:43:15] {2392} INFO -  at 87.9s,  estimator lgbm's
best error=0.0036,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:15] {2219} INFO - iteration 320, current
learner lgbm
[flaml.automl.logger: 07-10 09:43:15] {2392} INFO -  at 88.2s,  estimator lgbm's
best error=0.0036,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:15] {2219} INFO - iteration 321, current
learner xgboost
```

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[flaml.automl.logger: 07-10 09:43:15] {2392} INFO -  at 88.5s,  estimator
xgboost's best error=0.0045,  best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:15] {2219} INFO - iteration 322, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:15] {2392} INFO -  at 88.6s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:43:15] {2219} INFO - iteration 323, current
learner lgbm
[flaml.automl.logger: 07-10 09:43:16] {2392} INFO -  at 89.9s,  estimator lgbm's
best error=0.0036,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:16] {2219} INFO - iteration 324, current
learner rf
[flaml.automl.logger: 07-10 09:43:17] {2392} INFO -  at 90.2s,  estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:17] {2219} INFO - iteration 325, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:17] {2392} INFO -  at 90.3s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:43:17] {2219} INFO - iteration 326, current
learner rf
[flaml.automl.logger: 07-10 09:43:17] {2392} INFO -  at 90.6s,  estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:17] {2219} INFO - iteration 327, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:17] {2392} INFO -  at 90.8s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:43:17] {2219} INFO - iteration 328, current
learner lgbm
[flaml.automl.logger: 07-10 09:43:18] {2392} INFO -  at 91.3s,  estimator lgbm's
best error=0.0036,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:18] {2219} INFO - iteration 329, current
learner lgbm
[flaml.automl.logger: 07-10 09:43:19] {2392} INFO -  at 92.2s,  estimator lgbm's
best error=0.0036,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:19] {2219} INFO - iteration 330, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:19] {2392} INFO -  at 92.3s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:43:19] {2219} INFO - iteration 331, current
learner extra_tree
[flaml.automl.logger: 07-10 09:43:20] {2392} INFO -  at 93.4s,  estimator
extra_tree's best error=0.0055,       best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:43:20] {2219} INFO - iteration 332, current
```

```
learner lgbm
[flaml.automl.logger: 07-10 09:43:20] {2392} INFO -  at 93.9s,  estimator lgbm's
best error=0.0036,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:20] {2219} INFO - iteration 333, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:21] {2392} INFO -  at 94.1s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:43:21] {2219} INFO - iteration 334, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:21] {2392} INFO -  at 94.2s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:43:21] {2219} INFO - iteration 335, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:21] {2392} INFO -  at 94.3s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:43:21] {2219} INFO - iteration 336, current
learner lgbm
[flaml.automl.logger: 07-10 09:43:21] {2392} INFO -  at 94.9s,  estimator lgbm's
best error=0.0036,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:21] {2219} INFO - iteration 337, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:22] {2392} INFO -  at 95.0s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:43:22] {2219} INFO - iteration 338, current
learner lgbm
[flaml.automl.logger: 07-10 09:43:22] {2392} INFO -  at 95.4s,  estimator lgbm's
best error=0.0036,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:22] {2219} INFO - iteration 339, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:22] {2392} INFO -  at 95.5s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:43:22] {2219} INFO - iteration 340, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:22] {2392} INFO -  at 95.6s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:43:22] {2219} INFO - iteration 341, current
learner lgbm
[flaml.automl.logger: 07-10 09:43:23] {2392} INFO -  at 96.3s,  estimator lgbm's
best error=0.0036,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:23] {2219} INFO - iteration 342, current
learner rf
[flaml.automl.logger: 07-10 09:43:23] {2392} INFO -  at 96.7s,  estimator rf's
```

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best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:23] {2219} INFO - iteration 343, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:23] {2392} INFO -  at 96.8s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:43:23] {2219} INFO - iteration 344, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:24] {2392} INFO -  at 97.0s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:43:24] {2219} INFO - iteration 345, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:24] {2392} INFO -  at 97.1s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:43:24] {2219} INFO - iteration 346, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:24] {2392} INFO -  at 97.2s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:43:24] {2219} INFO - iteration 347, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:24] {2392} INFO -  at 97.3s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:43:24] {2219} INFO - iteration 348, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:24] {2392} INFO -  at 97.4s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:43:24] {2219} INFO - iteration 349, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:24] {2392} INFO -  at 97.6s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:43:24] {2219} INFO - iteration 350, current
learner lgbm
[flaml.automl.logger: 07-10 09:43:25] {2392} INFO -  at 97.9s,  estimator lgbm's
best error=0.0036,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:25] {2219} INFO - iteration 351, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:25] {2392} INFO -  at 98.1s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:43:25] {2219} INFO - iteration 352, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:25] {2392} INFO -  at 98.3s,  estimator
```

```
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:43:25] {2219} INFO - iteration 353, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:25] {2392} INFO -  at 98.4s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:43:25] {2219} INFO - iteration 354, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:25] {2392} INFO -  at 98.5s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:43:25] {2219} INFO - iteration 355, current
learner lgbm
[flaml.automl.logger: 07-10 09:43:26] {2392} INFO -  at 99.3s,  estimator lgbm's
best error=0.0036,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:26] {2219} INFO - iteration 356, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:26] {2392} INFO -  at 99.4s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:43:26] {2219} INFO - iteration 357, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:26] {2392} INFO -  at 99.5s,  estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:43:26] {2219} INFO - iteration 358, current
learner rf
[flaml.automl.logger: 07-10 09:43:26] {2392} INFO -  at 99.8s,  estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:26] {2219} INFO - iteration 359, current
learner rf
[flaml.automl.logger: 07-10 09:43:27] {2392} INFO -  at 100.0s, estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:27] {2219} INFO - iteration 360, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:27] {2392} INFO -  at 100.1s, estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:43:27] {2219} INFO - iteration 361, current
learner rf
[flaml.automl.logger: 07-10 09:43:27] {2392} INFO -  at 100.4s, estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:27] {2219} INFO - iteration 362, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:27] {2392} INFO -  at 100.5s, estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
```

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[flaml.automl.logger: 07-10 09:43:27] {2219} INFO - iteration 363, current
learner xgboost
[flaml.automl.logger: 07-10 09:43:27] {2392} INFO -  at 100.7s, estimator
xgboost's best error=0.0045,  best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:27] {2219} INFO - iteration 364, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:28] {2392} INFO -  at 100.9s, estimator
xgb_limitdepth's best error=0.0036,   best estimator xgb_limitdepth's best
error=0.0036
[flaml.automl.logger: 07-10 09:43:28] {2219} INFO - iteration 365, current
learner lrl1
[flaml.automl.logger: 07-10 09:43:28] {2392} INFO -  at 101.3s, estimator lrl1's
best error=0.0471,     best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:28] {2219} INFO - iteration 366, current
learner rf
[flaml.automl.logger: 07-10 09:43:28] {2392} INFO -  at 101.5s, estimator rf's
best error=0.0036,       best estimator xgb_limitdepth's best error=0.0036
[flaml.automl.logger: 07-10 09:43:28] {2219} INFO - iteration 367, current
learner lgbm
[flaml.automl.logger: 07-10 09:43:29] {2392} INFO -  at 102.7s, estimator lgbm's
best error=0.0035,     best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:29] {2219} INFO - iteration 368, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:29] {2392} INFO -  at 102.8s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:29] {2219} INFO - iteration 369, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:30] {2392} INFO -  at 103.0s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:30] {2219} INFO - iteration 370, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:30] {2392} INFO -  at 103.1s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:30] {2219} INFO - iteration 371, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:30] {2392} INFO -  at 103.2s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:30] {2219} INFO - iteration 372, current
learner lrl1
[flaml.automl.logger: 07-10 09:43:30] {2392} INFO -  at 103.5s, estimator lrl1's
best error=0.0471,     best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:30] {2219} INFO - iteration 373, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:30] {2392} INFO -  at 103.6s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:30] {2219} INFO - iteration 374, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:30] {2392} INFO -  at 103.7s, estimator
```

```
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:30] {2219} INFO - iteration 375, current
learner lgbm
[flaml.automl.logger: 07-10 09:43:31] {2392} INFO -  at 104.2s, estimator lgbm's
best error=0.0035,     best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:31] {2219} INFO - iteration 376, current
learner xgboost
[flaml.automl.logger: 07-10 09:43:31] {2392} INFO -  at 104.5s, estimator
xgboost's best error=0.0045,  best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:31] {2219} INFO - iteration 377, current
learner lgbm
[flaml.automl.logger: 07-10 09:43:32] {2392} INFO -  at 105.2s, estimator lgbm's
best error=0.0035,     best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:32] {2219} INFO - iteration 378, current
learner lgbm
[flaml.automl.logger: 07-10 09:43:33] {2392} INFO -  at 106.4s, estimator lgbm's
best error=0.0035,     best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:33] {2219} INFO - iteration 379, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:33] {2392} INFO -  at 106.6s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:33] {2219} INFO - iteration 380, current
learner lgbm
[flaml.automl.logger: 07-10 09:43:33] {2392} INFO -  at 106.8s, estimator lgbm's
best error=0.0035,     best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:33] {2219} INFO - iteration 381, current
learner xgboost
[flaml.automl.logger: 07-10 09:43:34] {2392} INFO -  at 107.0s, estimator
xgboost's best error=0.0045,  best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:34] {2219} INFO - iteration 382, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:34] {2392} INFO -  at 107.2s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:34] {2219} INFO - iteration 383, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:34] {2392} INFO -  at 107.3s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:34] {2219} INFO - iteration 384, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:34] {2392} INFO -  at 107.4s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:34] {2219} INFO - iteration 385, current
learner lgbm
[flaml.automl.logger: 07-10 09:43:36] {2392} INFO -  at 109.2s, estimator lgbm's
best error=0.0035,     best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:36] {2219} INFO - iteration 386, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:36] {2392} INFO -  at 109.5s, estimator
```

```
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:36] {2219} INFO - iteration 387, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:36] {2392} INFO -  at 109.7s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:36] {2219} INFO - iteration 388, current
learner lrl1
[flaml.automl.logger: 07-10 09:43:37] {2392} INFO -  at 110.0s, estimator lrl1's
best error=0.0471,     best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:37] {2219} INFO - iteration 389, current
learner lgbm
[flaml.automl.logger: 07-10 09:43:37] {2392} INFO -  at 110.3s, estimator lgbm's
best error=0.0035,     best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:37] {2219} INFO - iteration 390, current
learner lgbm
[flaml.automl.logger: 07-10 09:43:38] {2392} INFO -  at 111.8s, estimator lgbm's
best error=0.0035,     best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:38] {2219} INFO - iteration 391, current
learner lgbm
[flaml.automl.logger: 07-10 09:43:39] {2392} INFO -  at 112.8s, estimator lgbm's
best error=0.0035,     best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:39] {2219} INFO - iteration 392, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:40] {2392} INFO -  at 112.9s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:40] {2219} INFO - iteration 393, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:40] {2392} INFO -  at 113.0s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:40] {2219} INFO - iteration 394, current
learner lgbm
[flaml.automl.logger: 07-10 09:43:40] {2392} INFO -  at 113.9s, estimator lgbm's
best error=0.0035,     best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:40] {2219} INFO - iteration 395, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:41] {2392} INFO -  at 114.2s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:41] {2219} INFO - iteration 396, current
learner lgbm
[flaml.automl.logger: 07-10 09:43:41] {2392} INFO -  at 114.6s, estimator lgbm's
best error=0.0035,     best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:41] {2219} INFO - iteration 397, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:41] {2392} INFO -  at 114.7s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:41] {2219} INFO - iteration 398, current
learner lgbm
[flaml.automl.logger: 07-10 09:43:44] {2392} INFO -  at 117.4s, estimator lgbm's
```

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best error=0.0035,     best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:44] {2219} INFO - iteration 399, current
learner lgbm
[flaml.automl.logger: 07-10 09:43:46] {2392} INFO -  at 119.9s, estimator lgbm's
best error=0.0035,     best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:46] {2219} INFO - iteration 400, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:47] {2392} INFO -  at 120.1s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:47] {2219} INFO - iteration 401, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:47] {2392} INFO -  at 120.2s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:47] {2219} INFO - iteration 402, current
learner rf
[flaml.automl.logger: 07-10 09:43:47] {2392} INFO -  at 120.6s, estimator rf's
best error=0.0036,       best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:47] {2219} INFO - iteration 403, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:47] {2392} INFO -  at 120.8s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:47] {2219} INFO - iteration 404, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:48] {2392} INFO -  at 120.9s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:48] {2219} INFO - iteration 405, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:48] {2392} INFO -  at 121.1s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:48] {2219} INFO - iteration 406, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:48] {2392} INFO -  at 121.2s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:48] {2219} INFO - iteration 407, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:48] {2392} INFO -  at 121.3s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:48] {2219} INFO - iteration 408, current
learner lgbm
[flaml.automl.logger: 07-10 09:43:48] {2392} INFO -  at 121.7s, estimator lgbm's
best error=0.0035,     best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:48] {2219} INFO - iteration 409, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:48] {2392} INFO -  at 121.8s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:48] {2219} INFO - iteration 410, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:49] {2392} INFO -  at 122.0s, estimator
```

```
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:49] {2219} INFO - iteration 411, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:49] {2392} INFO -  at 122.1s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:49] {2219} INFO - iteration 412, current
learner lgbm
[flaml.automl.logger: 07-10 09:43:49] {2392} INFO -  at 122.6s, estimator lgbm's
best error=0.0035,     best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:49] {2219} INFO - iteration 413, current
learner lgbm
[flaml.automl.logger: 07-10 09:43:50] {2392} INFO -  at 123.6s, estimator lgbm's
best error=0.0035,     best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:50] {2219} INFO - iteration 414, current
learner lgbm
[flaml.automl.logger: 07-10 09:43:53] {2392} INFO -  at 126.0s, estimator lgbm's
best error=0.0035,     best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:53] {2219} INFO - iteration 415, current
learner xgboost
[flaml.automl.logger: 07-10 09:43:53] {2392} INFO -  at 126.2s, estimator
xgboost's best error=0.0044,  best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:53] {2219} INFO - iteration 416, current
learner lgbm
[flaml.automl.logger: 07-10 09:43:53] {2392} INFO -  at 126.4s, estimator lgbm's
best error=0.0035,     best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:53] {2219} INFO - iteration 417, current
learner extra_tree
[flaml.automl.logger: 07-10 09:43:54] {2392} INFO -  at 127.0s, estimator
extra_tree's best error=0.0055,       best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:54] {2219} INFO - iteration 418, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:54] {2392} INFO -  at 127.2s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:54] {2219} INFO - iteration 419, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:54] {2392} INFO -  at 127.3s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:54] {2219} INFO - iteration 420, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:54] {2392} INFO -  at 127.5s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:54] {2219} INFO - iteration 421, current
learner xgboost
[flaml.automl.logger: 07-10 09:43:54] {2392} INFO -  at 127.7s, estimator
xgboost's best error=0.0044,  best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:54] {2219} INFO - iteration 422, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:54] {2392} INFO -  at 127.8s, estimator
```

```
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:54] {2219} INFO - iteration 423, current
learner xgboost
[flaml.automl.logger: 07-10 09:43:55] {2392} INFO -  at 128.0s, estimator
xgboost's best error=0.0044,  best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:55] {2219} INFO - iteration 424, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:55] {2392} INFO -  at 128.2s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:55] {2219} INFO - iteration 425, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:43:55] {2392} INFO -  at 128.3s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:55] {2219} INFO - iteration 426, current
learner lgbm
[flaml.automl.logger: 07-10 09:43:58] {2392} INFO -  at 131.6s, estimator lgbm's
best error=0.0035,     best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:58] {2219} INFO - iteration 427, current
learner lgbm
[flaml.automl.logger: 07-10 09:43:59] {2392} INFO -  at 132.1s, estimator lgbm's
best error=0.0035,     best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:43:59] {2219} INFO - iteration 428, current
learner lgbm
[flaml.automl.logger: 07-10 09:44:02] {2392} INFO -  at 135.2s, estimator lgbm's
best error=0.0035,     best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:02] {2219} INFO - iteration 429, current
learner lgbm
[flaml.automl.logger: 07-10 09:44:02] {2392} INFO -  at 135.5s, estimator lgbm's
best error=0.0035,     best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:02] {2219} INFO - iteration 430, current
learner xgboost
[flaml.automl.logger: 07-10 09:44:02] {2392} INFO -  at 135.6s, estimator
xgboost's best error=0.0044,  best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:02] {2219} INFO - iteration 431, current
learner lgbm
[flaml.automl.logger: 07-10 09:44:03] {2392} INFO -  at 136.3s, estimator lgbm's
best error=0.0035,     best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:03] {2219} INFO - iteration 432, current
learner lgbm
[flaml.automl.logger: 07-10 09:44:06] {2392} INFO -  at 139.0s, estimator lgbm's
best error=0.0035,     best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:06] {2219} INFO - iteration 433, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:44:06] {2392} INFO -  at 139.1s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:06] {2219} INFO - iteration 434, current
learner xgboost
[flaml.automl.logger: 07-10 09:44:06] {2392} INFO -  at 139.3s, estimator
```

```
xgboost's best error=0.0044,  best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:06] {2219} INFO - iteration 435, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:44:06] {2392} INFO -  at 139.4s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:06] {2219} INFO - iteration 436, current
learner xgboost
[flaml.automl.logger: 07-10 09:44:06] {2392} INFO -  at 139.6s, estimator
xgboost's best error=0.0044,  best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:06] {2219} INFO - iteration 437, current
learner xgboost
[flaml.automl.logger: 07-10 09:44:06] {2392} INFO -  at 139.7s, estimator
xgboost's best error=0.0044,  best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:06] {2219} INFO - iteration 438, current
learner xgboost
[flaml.automl.logger: 07-10 09:44:07] {2392} INFO -  at 139.9s, estimator
xgboost's best error=0.0041,  best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:07] {2219} INFO - iteration 439, current
learner xgboost
[flaml.automl.logger: 07-10 09:44:07] {2392} INFO -  at 140.1s, estimator
xgboost's best error=0.0041,  best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:07] {2219} INFO - iteration 440, current
learner xgboost
[flaml.automl.logger: 07-10 09:44:07] {2392} INFO -  at 140.2s, estimator
xgboost's best error=0.0041,  best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:07] {2219} INFO - iteration 441, current
learner xgboost
[flaml.automl.logger: 07-10 09:44:07] {2392} INFO -  at 140.4s, estimator
xgboost's best error=0.0041,  best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:07] {2219} INFO - iteration 442, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:44:07] {2392} INFO -  at 140.5s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:07] {2219} INFO - iteration 443, current
learner lgbm
[flaml.automl.logger: 07-10 09:44:07] {2392} INFO -  at 140.8s, estimator lgbm's
best error=0.0035,     best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:07] {2219} INFO - iteration 444, current
learner xgboost
[flaml.automl.logger: 07-10 09:44:08] {2392} INFO -  at 140.9s, estimator
xgboost's best error=0.0041,  best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:08] {2219} INFO - iteration 445, current
learner lgbm
[flaml.automl.logger: 07-10 09:44:11] {2392} INFO -  at 144.1s, estimator lgbm's
best error=0.0035,     best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:11] {2219} INFO - iteration 446, current
learner xgboost
[flaml.automl.logger: 07-10 09:44:11] {2392} INFO -  at 144.5s, estimator
```

```
xgboost's best error=0.0041,  best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:11] {2219} INFO - iteration 447, current
learner lgbm
[flaml.automl.logger: 07-10 09:44:12] {2392} INFO -  at 145.6s, estimator lgbm's
best error=0.0035,     best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:12] {2219} INFO - iteration 448, current
learner xgboost
[flaml.automl.logger: 07-10 09:44:13] {2392} INFO -  at 146.1s, estimator
xgboost's best error=0.0041,  best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:13] {2219} INFO - iteration 449, current
learner lgbm
[flaml.automl.logger: 07-10 09:44:18] {2392} INFO -  at 151.5s, estimator lgbm's
best error=0.0035,     best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:18] {2219} INFO - iteration 450, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:44:18] {2392} INFO -  at 151.6s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:18] {2219} INFO - iteration 451, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:44:18] {2392} INFO -  at 151.8s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:18] {2219} INFO - iteration 452, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:44:18] {2392} INFO -  at 151.9s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:18] {2219} INFO - iteration 453, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:44:19] {2392} INFO -  at 152.0s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:19] {2219} INFO - iteration 454, current
learner lgbm
[flaml.automl.logger: 07-10 09:44:23] {2392} INFO -  at 156.2s, estimator lgbm's
best error=0.0035,     best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:23] {2219} INFO - iteration 455, current
learner lgbm
[flaml.automl.logger: 07-10 09:44:26] {2392} INFO -  at 159.6s, estimator lgbm's
best error=0.0035,     best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:26] {2219} INFO - iteration 456, current
learner rf
[flaml.automl.logger: 07-10 09:44:26] {2392} INFO -  at 159.9s, estimator rf's
best error=0.0036,       best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:26] {2219} INFO - iteration 457, current
learner xgboost
[flaml.automl.logger: 07-10 09:44:27] {2392} INFO -  at 160.0s, estimator
xgboost's best error=0.0041,  best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:27] {2219} INFO - iteration 458, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:44:27] {2392} INFO -  at 160.1s, estimator
```

```
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:27] {2219} INFO - iteration 459, current
learner lrl1
[flaml.automl.logger: 07-10 09:44:27] {2392} INFO -  at 160.5s, estimator lrl1's
best error=0.0471,     best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:27] {2219} INFO - iteration 460, current
learner extra_tree
[flaml.automl.logger: 07-10 09:44:28] {2392} INFO -  at 160.9s, estimator
extra_tree's best error=0.0055,       best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:28] {2219} INFO - iteration 461, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:44:28] {2392} INFO -  at 161.0s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:28] {2219} INFO - iteration 462, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:44:28] {2392} INFO -  at 161.1s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:28] {2219} INFO - iteration 463, current
learner xgboost
[flaml.automl.logger: 07-10 09:44:28] {2392} INFO -  at 161.3s, estimator
xgboost's best error=0.0041,  best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:28] {2219} INFO - iteration 464, current
learner xgboost
[flaml.automl.logger: 07-10 09:44:28] {2392} INFO -  at 161.4s, estimator
xgboost's best error=0.0041,  best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:28] {2219} INFO - iteration 465, current
learner lgbm
[flaml.automl.logger: 07-10 09:44:30] {2392} INFO -  at 163.4s, estimator lgbm's
best error=0.0035,     best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:30] {2219} INFO - iteration 466, current
learner lgbm
[flaml.automl.logger: 07-10 09:44:33] {2392} INFO -  at 166.3s, estimator lgbm's
best error=0.0035,     best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:33] {2219} INFO - iteration 467, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:44:33] {2392} INFO -  at 166.5s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:33] {2219} INFO - iteration 468, current
learner lgbm
[flaml.automl.logger: 07-10 09:44:34] {2392} INFO -  at 167.1s, estimator lgbm's
best error=0.0035,     best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:34] {2219} INFO - iteration 469, current
learner xgboost
[flaml.automl.logger: 07-10 09:44:34] {2392} INFO -  at 167.3s, estimator
xgboost's best error=0.0041,  best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:34] {2219} INFO - iteration 470, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:44:34] {2392} INFO -  at 167.5s, estimator
```

```
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:34] {2219} INFO - iteration 471, current
learner xgboost
[flaml.automl.logger: 07-10 09:44:34] {2392} INFO -  at 167.7s, estimator
xgboost's best error=0.0041,  best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:34] {2219} INFO - iteration 472, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:44:34] {2392} INFO -  at 167.8s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:34] {2219} INFO - iteration 473, current
learner xgboost
[flaml.automl.logger: 07-10 09:44:35] {2392} INFO -  at 168.0s, estimator
xgboost's best error=0.0041,  best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:35] {2219} INFO - iteration 474, current
learner xgboost
[flaml.automl.logger: 07-10 09:44:35] {2392} INFO -  at 168.4s, estimator
xgboost's best error=0.0041,  best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:35] {2219} INFO - iteration 475, current
learner xgboost
[flaml.automl.logger: 07-10 09:44:35] {2392} INFO -  at 168.9s, estimator
xgboost's best error=0.0041,  best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:35] {2219} INFO - iteration 476, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:44:36] {2392} INFO -  at 168.9s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:36] {2219} INFO - iteration 477, current
learner xgboost
[flaml.automl.logger: 07-10 09:44:36] {2392} INFO -  at 169.0s, estimator
xgboost's best error=0.0041,  best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:36] {2219} INFO - iteration 478, current
learner xgboost
[flaml.automl.logger: 07-10 09:44:36] {2392} INFO -  at 169.2s, estimator
xgboost's best error=0.0041,  best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:36] {2219} INFO - iteration 479, current
learner xgboost
[flaml.automl.logger: 07-10 09:44:36] {2392} INFO -  at 169.7s, estimator
xgboost's best error=0.0041,  best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:36] {2219} INFO - iteration 480, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:44:37] {2392} INFO -  at 170.1s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:37] {2219} INFO - iteration 481, current
learner lgbm
[flaml.automl.logger: 07-10 09:44:46] {2392} INFO -  at 179.5s, estimator lgbm's
best error=0.0035,     best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:46] {2219} INFO - iteration 482, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:44:46] {2392} INFO -  at 179.7s, estimator
```

```
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:46] {2219} INFO - iteration 483, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:44:46] {2392} INFO -  at 179.9s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:46] {2219} INFO - iteration 484, current
learner lgbm
[flaml.automl.logger: 07-10 09:44:51] {2392} INFO -  at 184.5s, estimator lgbm's
best error=0.0035,     best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:51] {2219} INFO - iteration 485, current
learner xgboost
[flaml.automl.logger: 07-10 09:44:51] {2392} INFO -  at 184.7s, estimator
xgboost's best error=0.0041,  best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:51] {2219} INFO - iteration 486, current
learner xgboost
[flaml.automl.logger: 07-10 09:44:51] {2392} INFO -  at 184.9s, estimator
xgboost's best error=0.0041,  best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:51] {2219} INFO - iteration 487, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:44:52] {2392} INFO -  at 185.0s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:52] {2219} INFO - iteration 488, current
learner xgboost
[flaml.automl.logger: 07-10 09:44:52] {2392} INFO -  at 185.4s, estimator
xgboost's best error=0.0041,  best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:52] {2219} INFO - iteration 489, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:44:52] {2392} INFO -  at 185.5s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:52] {2219} INFO - iteration 490, current
learner xgboost
[flaml.automl.logger: 07-10 09:44:52] {2392} INFO -  at 185.7s, estimator
xgboost's best error=0.0041,  best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:52] {2219} INFO - iteration 491, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:44:52] {2392} INFO -  at 185.8s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:52] {2219} INFO - iteration 492, current
learner rf
[flaml.automl.logger: 07-10 09:44:53] {2392} INFO -  at 186.1s, estimator rf's
best error=0.0036,       best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:53] {2219} INFO - iteration 493, current
learner lgbm
[flaml.automl.logger: 07-10 09:44:55] {2392} INFO -  at 188.2s, estimator lgbm's
best error=0.0035,     best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:55] {2219} INFO - iteration 494, current
learner extra_tree
[flaml.automl.logger: 07-10 09:44:56] {2392} INFO -  at 189.3s, estimator
```

```
extra_tree's best error=0.0055,       best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:56] {2219} INFO - iteration 495, current
learner xgboost
[flaml.automl.logger: 07-10 09:44:56] {2392} INFO -  at 189.4s, estimator
xgboost's best error=0.0041,  best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:56] {2219} INFO - iteration 496, current
learner xgboost
[flaml.automl.logger: 07-10 09:44:56] {2392} INFO -  at 189.8s, estimator
xgboost's best error=0.0041,  best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:56] {2219} INFO - iteration 497, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:44:57] {2392} INFO -  at 190.0s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:57] {2219} INFO - iteration 498, current
learner xgboost
[flaml.automl.logger: 07-10 09:44:57] {2392} INFO -  at 190.3s, estimator
xgboost's best error=0.0041,  best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:57] {2219} INFO - iteration 499, current
learner lgbm
[flaml.automl.logger: 07-10 09:44:59] {2392} INFO -  at 192.5s, estimator lgbm's
best error=0.0035,     best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:59] {2219} INFO - iteration 500, current
learner xgboost
[flaml.automl.logger: 07-10 09:44:59] {2392} INFO -  at 192.7s, estimator
xgboost's best error=0.0041,  best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:59] {2219} INFO - iteration 501, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:44:59] {2392} INFO -  at 192.8s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:44:59] {2219} INFO - iteration 502, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:45:00] {2392} INFO -  at 193.0s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:45:00] {2219} INFO - iteration 503, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:45:00] {2392} INFO -  at 193.1s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:45:00] {2219} INFO - iteration 504, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:45:00] {2392} INFO -  at 193.2s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:45:00] {2219} INFO - iteration 505, current
learner lgbm
[flaml.automl.logger: 07-10 09:45:02] {2392} INFO -  at 195.9s, estimator lgbm's
best error=0.0035,     best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:45:02] {2219} INFO - iteration 506, current
learner lgbm
[flaml.automl.logger: 07-10 09:45:05] {2392} INFO -  at 198.4s, estimator lgbm's
```

```
best error=0.0035,     best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:45:05] {2219} INFO - iteration 507, current
learner xgboost
[flaml.automl.logger: 07-10 09:45:05] {2392} INFO -  at 198.5s, estimator
xgboost's best error=0.0041,  best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:45:05] {2219} INFO - iteration 508, current
learner xgboost
[flaml.automl.logger: 07-10 09:45:06] {2392} INFO -  at 199.0s, estimator
xgboost's best error=0.0041,  best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:45:06] {2219} INFO - iteration 509, current
learner xgboost
[flaml.automl.logger: 07-10 09:45:06] {2392} INFO -  at 199.2s, estimator
xgboost's best error=0.0041,  best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:45:06] {2219} INFO - iteration 510, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:45:06] {2392} INFO -  at 199.3s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:45:06] {2219} INFO - iteration 511, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:45:06] {2392} INFO -  at 199.4s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:45:06] {2219} INFO - iteration 512, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 09:45:06] {2392} INFO -  at 199.6s, estimator
xgb_limitdepth's best error=0.0036,   best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:45:06] {2219} INFO - iteration 513, current
learner xgboost
[flaml.automl.logger: 07-10 09:45:07] {2392} INFO -  at 199.9s, estimator
xgboost's best error=0.0041,  best estimator lgbm's best error=0.0035
[flaml.automl.logger: 07-10 09:45:07] {2628} INFO - retrain lgbm for 0.8s
[flaml.automl.logger: 07-10 09:45:07] {2631} INFO - retrained model:
LGBMClassifier(colsample_bytree=0.475897050920022,
               learning_rate=0.012162301391965858, max_bin=127,
               min_child_samples=14, n_estimators=1, n_jobs=-1, num_leaves=187,
               reg_alpha=0.014178509039718554, reg_lambda=0.3360805038433576,
               verbose=-1)
[flaml.automl.logger: 07-10 09:45:07] {1931} INFO - fit succeeded
[flaml.automl.logger: 07-10 09:45:07] {1932} INFO - Time taken to find the best
model: 144.11015605926514
```

[51]:
```
from sklearn.metrics import roc_auc_score, accuracy_score
pred=automl.predict(X_test)
#y_scores = automl.decision_function(X_test)
acc_automl = accuracy_score(y_test,pred)
score=automl.predict_proba(X_test)
y_score=score[:,1]
roc_automl=roc_auc_score(y_test,y_score)
```

[51]: 0.9796296296296296

[45]:
```
best_models={'KNN': KNN(algorithm='auto', contamination=0.1, leaf_size=10,␣
 ↪method='mean',
  metric='euclidean', metric_params=None, n_jobs=1, n_neighbors=5,␣
 ↪p=2,radius=1.0),

 'LOF': LOF(algorithm='ball_tree', contamination=0.01, leaf_size=30,
  metric='manhattan', metric_params=None, n_jobs=1, n_neighbors=20,
  novelty=True, p=2),

 'HBOS': HBOS(alpha=0.9, contamination=0.01, n_bins=40, tol=0.5),
 'IForest': IForest(behaviour='new', bootstrap=False, contamination=0.1,␣
 ↪max_features=0.7,
    max_samples=0.5, n_estimators=50, n_jobs=1, random_state=None,
    verbose=0),

 'PCA': PCA(contamination=0.1, copy=True, iterated_power='auto', n_components=2,
  n_selected_components=None, random_state=None, standardization=True,
  svd_solver='auto', tol=0.0, weighted=True, whiten=True),

 'MCD':  MCD(assume_centered=False, contamination=0.01, random_state=None,
           store_precision=True, support_fraction=None),

 'OCSVM': OCSVM(cache_size=200, coef0=0.0, contamination=0.1, degree=3,␣
 ↪gamma='scale',
   kernel='rbf', max_iter=-1, nu=0.01, shrinking=True, tol=0.001,
   verbose=False),

 'KDE': KDE(algorithm='auto', bandwidth=1.0, contamination=0.01, leaf_size=30,
  metric='minkowski', metric_params=None)}
```

[47]:
```
# Example of evaluating models using ROC AUC score (or other appropriate␣
 ↪metrics)
results = {}
accuracy={}
for name, model in best_models.items():
    model.fit(X_train, y_train)
    score=model.predict_proba(X_test)
    y_score=score[:,1]
    y_scores = model.decision_function(X_test)
    y_test_pred = model.predict(X_test)
    roc_auc = roc_auc_score(y_test, y_score)
    acc = accuracy_score(y_test,y_test_pred  )
    results[name] = roc_auc
    accuracy[name] = acc
```

```
# Print or analyze results
print("ROC AUC Scores:")
print(results)
print("Accuracy Scores:")
print(accuracy)
```

```
ROC AUC Scores:
{'KNN': 0.7673781249999999, 'LOF': 0.770096875, 'HBOS': 0.7543078125, 'IForest':
0.8419499999999999, 'PCA': 0.6861906249999999, 'MCD': 0.9198312500000001,
'OCSVM': 0.649525, 'KDE': 0.54524375}
Accuracy Scores:
{'KNN': 0.8930555555555556, 'LOF': 0.9231481481481482, 'HBOS':
0.9319444444444445, 'IForest': 0.8856481481481482, 'PCA': 0.875462962962963,
'MCD': 0.9342592592592592, 'OCSVM': 0.8662037037037037, 'KDE':
0.9212962962962963}
```

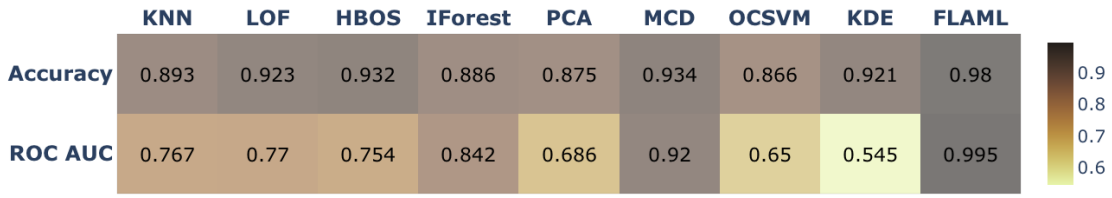
[49]:
```
np.round(results['KNN'],3)
```

[49]:
```
0.767
```

[56]:
```
import numpy as np
import plotly.graph_objects as go
from functools import reduce
from itertools import product
from IPython.display import Image
SUB = str.maketrans("0123456789", "₀₁₂₃₄₅₆₇₈₉")
SUP = str.maketrans("0123456789", "⁰¹²³⁴⁵⁶⁷⁸⁹")
z=[ [np.round(results['KNN'],3),np.round(results['LOF'],3),np.
 ↪round(results['HBOS'],3),
    np.round(results['IForest'],3),np.round(results['PCA'],3),np.
 ↪round(results['MCD'],3),
   np.round(results['OCSVM'],3),np.round(results['KDE'],3),np.
 ↪round(roc_automl,3)],


  [np.round(accuracy['KNN'],3),
   np.round(accuracy['LOF'],3),np.round(accuracy['HBOS'],3),np.
 ↪round(accuracy['IForest'],3),
   np.round(accuracy['PCA'],3),np.round(accuracy['MCD'],3),np.
 ↪round(accuracy['OCSVM'],3),
   np.round(accuracy['KDE'],3),np.round(acc_automl,3)]]
x=['<b>KNN</b>', '<b>LOF</b>', '<b>HBOS</b>', '<b>IForest</b>', '<b>PCA</
 ↪b>','<b>MCD</b>',
  '<b>OCSVM</b>','<b>KDE</b>','<b>FLAML</b>']
y=['<b>ROC AUC</b>','<b>Accuracy</b>']

def get_anno_text(z_value):
```

```
    annotations=[]
    a, b = len(z_value), len(z_value[0])
    flat_z = reduce(lambda x,y: x+y, z_value) # z_value.flat if you deal with␣
 ↪numpy
    coords = product(range(a), range(b))
    for pos, elem in zip(coords, flat_z):
        annotations.append({'font': {'color': 'black'},
                    'showarrow': False,
                    'text': str(elem),
                    'x': pos[1],
                    'y': pos[0],
                        'font.size':22   })
    return annotations

fig = go.Figure(data=go.Heatmap(
                    z=z,
                    x=x,
                    y=y,
                    hoverongaps = True, colorscale ='turbid',
    opacity=0.6,colorbar=dict(tickfont=dict(size=20)) ))#matter#

fig.update_layout(title={'text': "",
        'y':0.8,
        'x':0.5,
        'xanchor': 'center',
        'yanchor': 'top'},
          plot_bgcolor='rgba(0,0,0,0)',
    annotations = get_anno_text(z),
                width=1300,
height=250,xaxis={'side': 'top'},margin=dict(l=20, r=20, t=20, b=20))

fig.update_xaxes(tickfont = dict(size=24),linewidth=0.1, linecolor='black',

                 mirror=True)
fig.update_yaxes(tickfont = dict(size=24),linewidth=0.1, linecolor='black',

                 mirror=True)
fig.write_image("table2b.png",engine="kaleido")
#plt.savefig("table2a.pdf", format="pdf", bbox_inches="tight")
fig.show()
Image('table2b.png')
```

[56]:



20 Bank Data

[58]:
```
df=pd.read_csv('bank.csv')
df.head()
```

[58]:

	age	job=housemaid	job=services	job=admin.	job=blue-collar	\
0	0.209877	0	0	0	0	
1	0.296296	0	0	1	0	
2	0.246914	1	0	0	0	
3	0.160494	0	1	0	0	
4	0.530864	0	0	0	1	

	job=technician	job=retired	job=management	job=unemployed	\
0	0	0	0	0	
1	0	0	0	0	
2	0	0	0	0	
3	0	0	0	0	
4	0	0	0	0	

	job=self-employed	…	previous	poutcome=nonexistent	poutcome=failure	\
0	0	…	0.000000	1	0	
1	0	…	0.000000	1	0	
2	0	…	0.000000	1	0	
3	0	…	0.142857	0	1	
4	0	…	0.000000	1	0	

	poutcome=success	emp.var.rate	cons.price.idx	cons.conf.idx	euribor3m	\
0	0	1.000000	0.882307	0.376569	0.980730	
1	0	1.000000	0.484412	0.615063	0.981183	
2	0	0.937500	0.698753	0.602510	0.957379	
3	0	0.333333	0.269680	0.192469	0.150759	
4	0	0.333333	0.340608	0.154812	0.174790	

	nr.employed	class
0	1.000000	0
1	1.000000	0
2	0.859735	0

```
3     0.512287      0
4     0.512287      1

[5 rows x 63 columns]
```

[61]:
```
X = df.drop("class", axis=1).values

y = df["class"]
```

[65]:
```
# split the data into training and testing sets
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3,␣
 ↪random_state=42, stratify=y)

print(f"Training set shape: {X_train.shape}")
print(f"Test set shape: {X_test.shape}")
```

```
Training set shape: (28831, 62)
Test set shape: (12357, 62)
```

21 Define models to evaluate

models = { 'KNN': KNN(), 'LOF': LOF(), 'HBOS': HBOS(), 'IForest': IForest(), 'PCA': PCA(), 'MCD': MCD(), 'OCSVM': OCSVM(), 'KDE': KDE() #'ABOD': ABOD() #'COF': COF(), #'LOCI': LOCI(), #'SOD': SOD() }

22 Define parameter grids for each model

param_grids = { 'KNN': { 'n_neighbors': [5, 10, 15, 20], 'method': ['largest', 'mean', 'median', 'distance'], 'metric': ['euclidean', 'manhattan', 'chebyshev', 'minkowski'], 'leaf_size': [10, 20, 30], 'algorithm': ['auto', 'ball_tree', 'kd_tree', 'brute'] }, 'LOF': { 'n_neighbors': [5, 10, 15, 20], 'algorithm': ['auto', 'ball_tree', 'kd_tree', 'brute'], 'contamination': [0.01, 0.05, 0.1, 0.15], 'metric': ['minkowski', 'manhattan', 'euclidean'] }, 'HBOS': { 'n_bins': [10, 20, 30, 40], 'alpha': [0.1, 0.3, 0.6, 0.9], 'contamination': [0.01, 0.05, 0.1, 0.15] }, 'IForest': { 'n_estimators': [50, 100, 150, 200], 'max_samples': [0.5, 0.7, 1.0], 'contamination': [0.01, 0.05, 0.1, 0.15], 'bootstrap': [True, False], 'max_features': [0.5, 0.7, 1.0], 'behaviour': ['new', 'old'] }, 'PCA': { 'n_components': [2, 5, 10, 20], 'whiten': [True, False], 'svd_solver': ['auto', 'full', 'arpack', 'randomized'] }, 'MCD': { 'contamination': [0.01, 0.05, 0.1, 0.15] }, 'OCSVM': { 'kernel': ['rbf', 'linear', 'poly', 'sigmoid'], 'nu': [0.01, 0.05, 0.1, 0.15], 'gamma': ['auto', 'scale'] }, 'KDE': {'contamination': [0.01, 0.05, 0.1, 0.15]} }

23 Perform grid search and tune models

best_models = {} for name, model in models.items(): param_grid = param_grids[name] grid_search = GridSearchCV(model, param_grid, scoring='roc_auc', cv=5, verbose=1) grid_search.fit(X_train, y_train) best_model = grid_search.best_estimator_ best_models[name] = best_model

24 Print best models found by GridSearchCV

for name, model in best_models.items(): print(f"Best model for {name}:“) print(model) print()

25 Example of evaluating models using ROC AUC score (or other appropriate metrics)

results = {} for name, model in best_models.items(): y_scores = model.decision_function(X_test) roc_auc = roc_auc_score(y_test, y_scores) results[name] = roc_auc

26 Print or analyze results

print(“ROC AUC Scores:”) print(results)

[67]:
```
best_models={'KNN': KNN(algorithm='auto', contamination=0.1, leaf_size=10,␣
↪method='mean',
  metric='euclidean', metric_params=None, n_jobs=1, n_neighbors=5,␣
↪p=2,radius=1.0),

'LOF': LOF(algorithm='ball_tree', contamination=0.01, leaf_size=30,
  metric='manhattan', metric_params=None, n_jobs=1, n_neighbors=20,
  novelty=True, p=2),

'HBOS': HBOS(alpha=0.9, contamination=0.01, n_bins=40, tol=0.5),
'IForest': IForest(behaviour='new', bootstrap=False, contamination=0.1,␣
↪max_features=0.7,
    max_samples=0.5, n_estimators=50, n_jobs=1, random_state=None,
    verbose=0),

'PCA': PCA(contamination=0.1, copy=True, iterated_power='auto', n_components=2,
  n_selected_components=None, random_state=None, standardization=True,
  svd_solver='auto', tol=0.0, weighted=True, whiten=True),

'MCD':  MCD(assume_centered=False, contamination=0.01, random_state=None,
          store_precision=True, support_fraction=None),

'OCSVM': OCSVM(cache_size=200, coef0=0.0, contamination=0.1, degree=3,␣
↪gamma='scale',
   kernel='rbf', max_iter=-1, nu=0.01, shrinking=True, tol=0.001,
   verbose=False),

'KDE': KDE(algorithm='auto', bandwidth=1.0, contamination=0.01, leaf_size=30,
  metric='minkowski', metric_params=None)}
```

[68]:
```
```

```
# Example of evaluating models using ROC AUC score (or other appropriate␣
 ↪metrics)
results = {}
accuracy={}
for name, model in best_models.items():
    model.fit(X_train, y_train)
    score=model.predict_proba(X_test)
    y_score=score[:,1]
    y_scores = model.decision_function(X_test)
    y_test_pred = model.predict(X_test)
    roc_auc = roc_auc_score(y_test, y_score)
    acc = accuracy_score(y_test,y_test_pred )
    print(acc)
    print(roc_auc )
    results[name] = roc_auc
    accuracy[name] = acc
# Print or analyze results
print("ROC AUC Scores:")
print(results)
print("Accuracy Scores:")
print(accuracy)
```

```
---------------------------------------------------------------------------
AttributeError                            Traceback (most recent call last)
File /opt/anaconda3/envs/Project/lib/python3.8/site-packages/pyod/models/lof.py
 ↪215, in LOF.decision_function(self, X)
    214 try:
--> 215     return invert_order(self.detector_._score_samples(X))
    216 except AttributeError:

AttributeError: 'LocalOutlierFactor' object has no attribute '_score_samples'

During handling of the above exception, another exception occurred:

AttributeError                            Traceback (most recent call last)
File /opt/anaconda3/envs/Project/lib/python3.8/site-packages/pyod/models/lof.py
 ↪218, in LOF.decision_function(self, X)
    217 try:
--> 218     return invert_order(self.detector_._decision_function(X))
    219 except AttributeError:

AttributeError: 'LocalOutlierFactor' object has no attribute '_decision_functio'

During handling of the above exception, another exception occurred:

KeyboardInterrupt                         Traceback (most recent call last)
Cell In[68], line 6
```

```
      4 for name, model in best_models.items():
      5     model.fit(X_train, y_train)
----> 6     score=model.predict_proba(X_test)
      7     y_score=score[:,1]
      8     y_scores = model.decision_function(X_test)

File /opt/anaconda3/envs/Project/lib/python3.8/site-packages/pyod/models/base.py:
 ↪213, in BaseDetector.predict_proba(self, X, method, return_confidence)
    210 check_is_fitted(self, ['decision_scores_', 'threshold_', 'labels_'])
    211 train_scores = self.decision_scores_
--> 213 test_scores = self.decision_function(X)
    215 probs = np.zeros([X.shape[0], int(self._classes)])
    216 if method == 'linear':

File /opt/anaconda3/envs/Project/lib/python3.8/site-packages/pyod/models/lof.py
 ↪220, in LOF.decision_function(self, X)
    218     return invert_order(self.detector_._decision_function(X))
    219 except AttributeError:
--> 220     return invert_order(self.detector_.score_samples(X))

File /opt/anaconda3/envs/Project/lib/python3.8/site-packages/sklearn/neighbors/
 ↪_lof.py:454, in LocalOutlierFactor.score_samples(self, X)
    451 check_is_fitted(self)
    452 X = check_array(X, accept_sparse="csr")
--> 454 distances_X, neighbors_indices_X = self.kneighbors(
    455     X, n_neighbors=self.n_neighbors_
    456 )
    457 X_lrd = self._local_reachability_density(distances_X,␣
 ↪neighbors_indices_X)
    459 lrd_ratios_array = self._lrd[neighbors_indices_X] / X_lrd[:, np.newaxis]

File /opt/anaconda3/envs/Project/lib/python3.8/site-packages/sklearn/neighbors/
 ↪_base.py:814, in KNeighborsMixin.kneighbors(self, X, n_neighbors,␣
 ↪return_distance)
    808     if issparse(X):
    809         raise ValueError(
    810             "%s does not work with sparse matrices. Densify the data, "
    811             "or set algorithm='brute'"
    812             % self._fit_method
    813         )
--> 814     chunked_results = Parallel(n_jobs, prefer="threads")(
    815         delayed(_tree_query_parallel_helper)(
    816             self._tree, X[s], n_neighbors, return_distance
    817         )
    818         for s in gen_even_slices(X.shape[0], n_jobs)
    819     )
    820 else:
    821     raise ValueError("internal: _fit_method not recognized")
```

```
File /opt/anaconda3/envs/Project/lib/python3.8/site-packages/joblib/parallel.py
 ↪1085, in Parallel.__call__(self, iterable)
   1076 try:
   1077     # Only set self._iterating to True if at least a batch
   1078     # was dispatched. In particular this covers the edge
   (…)
   1082     # was very quick and its callback already dispatched all the
   1083     # remaining jobs.
   1084     self._iterating = False
-> 1085     if self.dispatch_one_batch(iterator):
   1086         self._iterating = self._original_iterator is not None
   1088     while self.dispatch_one_batch(iterator):

File /opt/anaconda3/envs/Project/lib/python3.8/site-packages/joblib/parallel.py
 ↪901, in Parallel.dispatch_one_batch(self, iterator)
    899     return False
    900 else:
--> 901     self._dispatch(tasks)
    902     return True

File /opt/anaconda3/envs/Project/lib/python3.8/site-packages/joblib/parallel.py
 ↪819, in Parallel._dispatch(self, batch)
    817 with self._lock:
    818     job_idx = len(self._jobs)
--> 819     job = self._backend.apply_async(batch, callback=cb)
    820     # A job can complete so quickly than its callback is
    821     # called before we get here, causing self._jobs to
    822     # grow. To ensure correct results ordering, .insert is
    823     # used (rather than .append) in the following line
    824     self._jobs.insert(job_idx, job)

File /opt/anaconda3/envs/Project/lib/python3.8/site-packages/joblib/
 ↪_parallel_backends.py:208, in SequentialBackend.apply_async(self, func,␣
 ↪callback)
    206 def apply_async(self, func, callback=None):
    207     """Schedule a func to be run"""
--> 208     result = ImmediateResult(func)
    209     if callback:
    210         callback(result)

File /opt/anaconda3/envs/Project/lib/python3.8/site-packages/joblib/
 ↪_parallel_backends.py:597, in ImmediateResult.__init__(self, batch)
    594 def __init__(self, batch):
    595     # Don't delay the application, to avoid keeping the input
    596     # arguments in memory
--> 597     self.results = batch()
```

```
File /opt/anaconda3/envs/Project/lib/python3.8/site-packages/joblib/parallel.py
 ↪288, in BatchedCalls.__call__(self)
    284 def __call__(self):
    285     # Set the default nested backend to self._backend but do not set th
    286     # change the default number of processes to -1
    287     with parallel_backend(self._backend, n_jobs=self._n_jobs):
--> 288         return [func(*args, **kwargs)
    289                 for func, args, kwargs in self.items]

File /opt/anaconda3/envs/Project/lib/python3.8/site-packages/joblib/parallel.py
 ↪288, in <listcomp>(.0)
    284 def __call__(self):
    285     # Set the default nested backend to self._backend but do not set th
    286     # change the default number of processes to -1
    287     with parallel_backend(self._backend, n_jobs=self._n_jobs):
--> 288         return [func(*args, **kwargs)
    289                 for func, args, kwargs in self.items]

File /opt/anaconda3/envs/Project/lib/python3.8/site-packages/sklearn/utils/fixe
 ↪py:117, in _FuncWrapper.__call__(self, *args, **kwargs)
    115 def __call__(self, *args, **kwargs):
    116     with config_context(**self.config):
--> 117         return self.function(*args, **kwargs)

File /opt/anaconda3/envs/Project/lib/python3.8/site-packages/sklearn/neighbors/
 ↪_base.py:623, in _tree_query_parallel_helper(tree, *args, **kwargs)
    617 def _tree_query_parallel_helper(tree, *args, **kwargs):
    618     """Helper for the Parallel calls in KNeighborsMixin.kneighbors.
    619
    620     The Cython method tree.query is not directly picklable by cloudpick
    621     under PyPy.
    622     """
--> 623     return tree.query(*args, **kwargs)

KeyboardInterrupt:
```

[69]:
```
from flaml import AutoML

automl = AutoML()

# Specify automl goal and constraint
automl_settings = {
    "time_budget": 200,       # total running time in seconds
    "task": 'classification', # task type
    "seed": 24545678,         # random seed
    "metric": 'roc_auc',      # use ROC AUC as the metric
```

```
}

# Fit the AutoML model with the specified settings
automl.fit(X_train=X_train, y_train=y_train, **automl_settings)
```

```
[flaml.automl.logger: 07-10 10:52:48] {1680} INFO - task = classification
[flaml.automl.logger: 07-10 10:52:48] {1691} INFO - Evaluation method: holdout
[flaml.automl.logger: 07-10 10:52:48] {1789} INFO - Minimizing error metric:
1-roc_auc
[flaml.automl.logger: 07-10 10:52:48] {1901} INFO - List of ML learners in
AutoML Run: ['lgbm', 'rf', 'xgboost', 'extra_tree', 'xgb_limitdepth', 'lrl1']
[flaml.automl.logger: 07-10 10:52:48] {2219} INFO - iteration 0, current learner
lgbm
[flaml.automl.logger: 07-10 10:52:48] {2345} INFO - Estimated sufficient time
budget=903s. Estimated necessary time budget=21s.
[flaml.automl.logger: 07-10 10:52:48] {2392} INFO -  at 0.2s,   estimator lgbm's
best error=0.0851,     best estimator lgbm's best error=0.0851
[flaml.automl.logger: 07-10 10:52:48] {2219} INFO - iteration 1, current learner
lgbm
[flaml.automl.logger: 07-10 10:52:48] {2392} INFO -  at 0.3s,   estimator lgbm's
best error=0.0851,     best estimator lgbm's best error=0.0851
[flaml.automl.logger: 07-10 10:52:48] {2219} INFO - iteration 2, current learner
lgbm
[flaml.automl.logger: 07-10 10:52:48] {2392} INFO -  at 0.4s,   estimator lgbm's
best error=0.0664,     best estimator lgbm's best error=0.0664
[flaml.automl.logger: 07-10 10:52:48] {2219} INFO - iteration 3, current learner
xgboost
[flaml.automl.logger: 07-10 10:52:48] {2392} INFO -  at 0.5s,   estimator
xgboost's best error=0.1215,  best estimator lgbm's best error=0.0664
[flaml.automl.logger: 07-10 10:52:48] {2219} INFO - iteration 4, current learner
lgbm
[flaml.automl.logger: 07-10 10:52:48] {2392} INFO -  at 0.6s,   estimator lgbm's
best error=0.0664,     best estimator lgbm's best error=0.0664
[flaml.automl.logger: 07-10 10:52:48] {2219} INFO - iteration 5, current learner
lgbm
[flaml.automl.logger: 07-10 10:52:48] {2392} INFO -  at 0.8s,   estimator lgbm's
best error=0.0541,     best estimator lgbm's best error=0.0541
[flaml.automl.logger: 07-10 10:52:48] {2219} INFO - iteration 6, current learner
lgbm
[flaml.automl.logger: 07-10 10:52:49] {2392} INFO -  at 0.9s,   estimator lgbm's
best error=0.0530,     best estimator lgbm's best error=0.0530
[flaml.automl.logger: 07-10 10:52:49] {2219} INFO - iteration 7, current learner
lgbm
[flaml.automl.logger: 07-10 10:52:49] {2392} INFO -  at 1.1s,   estimator lgbm's
best error=0.0530,     best estimator lgbm's best error=0.0530
[flaml.automl.logger: 07-10 10:52:49] {2219} INFO - iteration 8, current learner
lgbm
[flaml.automl.logger: 07-10 10:52:49] {2392} INFO -  at 1.4s,   estimator lgbm's
```

```
best error=0.0530,     best estimator lgbm's best error=0.0530
[flaml.automl.logger: 07-10 10:52:49] {2219} INFO - iteration 9, current learner
xgboost
[flaml.automl.logger: 07-10 10:52:49] {2392} INFO -  at 1.5s,   estimator
xgboost's best error=0.1215,  best estimator lgbm's best error=0.0530
[flaml.automl.logger: 07-10 10:52:49] {2219} INFO - iteration 10, current
learner extra_tree
[flaml.automl.logger: 07-10 10:52:49] {2392} INFO -  at 1.6s,   estimator
extra_tree's best error=0.2454,       best estimator lgbm's best error=0.0530
[flaml.automl.logger: 07-10 10:52:49] {2219} INFO - iteration 11, current
learner xgboost
[flaml.automl.logger: 07-10 10:52:49] {2392} INFO -  at 1.7s,   estimator
xgboost's best error=0.0753,  best estimator lgbm's best error=0.0530
[flaml.automl.logger: 07-10 10:52:49] {2219} INFO - iteration 12, current
learner extra_tree
[flaml.automl.logger: 07-10 10:52:49] {2392} INFO -  at 1.8s,   estimator
extra_tree's best error=0.1430,       best estimator lgbm's best error=0.0530
[flaml.automl.logger: 07-10 10:52:49] {2219} INFO - iteration 13, current
learner xgboost
[flaml.automl.logger: 07-10 10:52:50] {2392} INFO -  at 1.9s,   estimator
xgboost's best error=0.0753,  best estimator lgbm's best error=0.0530
[flaml.automl.logger: 07-10 10:52:50] {2219} INFO - iteration 14, current
learner extra_tree
[flaml.automl.logger: 07-10 10:52:50] {2392} INFO -  at 2.1s,   estimator
extra_tree's best error=0.1430,       best estimator lgbm's best error=0.0530
[flaml.automl.logger: 07-10 10:52:50] {2219} INFO - iteration 15, current
learner rf
[flaml.automl.logger: 07-10 10:52:50] {2392} INFO -  at 2.2s,   estimator rf's
best error=0.1197,       best estimator lgbm's best error=0.0530
[flaml.automl.logger: 07-10 10:52:50] {2219} INFO - iteration 16, current
learner rf
[flaml.automl.logger: 07-10 10:52:50] {2392} INFO -  at 2.3s,   estimator rf's
best error=0.1197,       best estimator lgbm's best error=0.0530
[flaml.automl.logger: 07-10 10:52:50] {2219} INFO - iteration 17, current
learner extra_tree
[flaml.automl.logger: 07-10 10:52:50] {2392} INFO -  at 2.5s,   estimator
extra_tree's best error=0.1430,       best estimator lgbm's best error=0.0530
[flaml.automl.logger: 07-10 10:52:50] {2219} INFO - iteration 18, current
learner lgbm
[flaml.automl.logger: 07-10 10:52:50] {2392} INFO -  at 2.6s,   estimator lgbm's
best error=0.0530,     best estimator lgbm's best error=0.0530
[flaml.automl.logger: 07-10 10:52:50] {2219} INFO - iteration 19, current
learner xgboost
[flaml.automl.logger: 07-10 10:52:51] {2392} INFO -  at 2.8s,   estimator
xgboost's best error=0.0591,  best estimator lgbm's best error=0.0530
[flaml.automl.logger: 07-10 10:52:51] {2219} INFO - iteration 20, current
learner rf
[flaml.automl.logger: 07-10 10:52:51] {2392} INFO -  at 3.0s,   estimator rf's
```

```
best error=0.1051,       best estimator lgbm's best error=0.0530
[flaml.automl.logger: 07-10 10:52:51] {2219} INFO - iteration 21, current
learner xgboost
[flaml.automl.logger: 07-10 10:52:51] {2392} INFO -  at 3.3s,   estimator
xgboost's best error=0.0591,  best estimator lgbm's best error=0.0530
[flaml.automl.logger: 07-10 10:52:51] {2219} INFO - iteration 22, current
learner lgbm
[flaml.automl.logger: 07-10 10:52:51] {2392} INFO -  at 3.4s,   estimator lgbm's
best error=0.0530,     best estimator lgbm's best error=0.0530
[flaml.automl.logger: 07-10 10:52:51] {2219} INFO - iteration 23, current
learner lgbm
[flaml.automl.logger: 07-10 10:52:51] {2392} INFO -  at 3.6s,   estimator lgbm's
best error=0.0530,     best estimator lgbm's best error=0.0530
[flaml.automl.logger: 07-10 10:52:51] {2219} INFO - iteration 24, current
learner extra_tree
[flaml.automl.logger: 07-10 10:52:51] {2392} INFO -  at 3.8s,   estimator
extra_tree's best error=0.1430,       best estimator lgbm's best error=0.0530
[flaml.automl.logger: 07-10 10:52:51] {2219} INFO - iteration 25, current
learner extra_tree
[flaml.automl.logger: 07-10 10:52:52] {2392} INFO -  at 3.9s,   estimator
extra_tree's best error=0.1430,       best estimator lgbm's best error=0.0530
[flaml.automl.logger: 07-10 10:52:52] {2219} INFO - iteration 26, current
learner rf
[flaml.automl.logger: 07-10 10:52:52] {2392} INFO -  at 4.1s,   estimator rf's
best error=0.1051,       best estimator lgbm's best error=0.0530
[flaml.automl.logger: 07-10 10:52:52] {2219} INFO - iteration 27, current
learner xgboost
[flaml.automl.logger: 07-10 10:52:52] {2392} INFO -  at 4.3s,   estimator
xgboost's best error=0.0591,  best estimator lgbm's best error=0.0530
[flaml.automl.logger: 07-10 10:52:52] {2219} INFO - iteration 28, current
learner extra_tree
[flaml.automl.logger: 07-10 10:52:52] {2392} INFO -  at 4.4s,   estimator
extra_tree's best error=0.1430,       best estimator lgbm's best error=0.0530
[flaml.automl.logger: 07-10 10:52:52] {2219} INFO - iteration 29, current
learner extra_tree
[flaml.automl.logger: 07-10 10:52:52] {2392} INFO -  at 4.6s,   estimator
extra_tree's best error=0.1355,       best estimator lgbm's best error=0.0530
[flaml.automl.logger: 07-10 10:52:52] {2219} INFO - iteration 30, current
learner lgbm
[flaml.automl.logger: 07-10 10:52:53] {2392} INFO -  at 5.0s,   estimator lgbm's
best error=0.0530,     best estimator lgbm's best error=0.0530
[flaml.automl.logger: 07-10 10:52:53] {2219} INFO - iteration 31, current
learner lgbm
[flaml.automl.logger: 07-10 10:52:53] {2392} INFO -  at 5.2s,   estimator lgbm's
best error=0.0530,     best estimator lgbm's best error=0.0530
[flaml.automl.logger: 07-10 10:52:53] {2219} INFO - iteration 32, current
learner lgbm
[flaml.automl.logger: 07-10 10:52:53] {2392} INFO -  at 5.3s,   estimator lgbm's
```

```
best error=0.0530,     best estimator lgbm's best error=0.0530
[flaml.automl.logger: 07-10 10:52:53] {2219} INFO - iteration 33, current
learner xgboost
[flaml.automl.logger: 07-10 10:52:53] {2392} INFO -  at 5.5s,   estimator
xgboost's best error=0.0591,  best estimator lgbm's best error=0.0530
[flaml.automl.logger: 07-10 10:52:53] {2219} INFO - iteration 34, current
learner lgbm
[flaml.automl.logger: 07-10 10:52:54] {2392} INFO -  at 6.0s,   estimator lgbm's
best error=0.0512,     best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:52:54] {2219} INFO - iteration 35, current
learner rf
[flaml.automl.logger: 07-10 10:52:54] {2392} INFO -  at 6.2s,   estimator rf's
best error=0.0921,       best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:52:54] {2219} INFO - iteration 36, current
learner xgboost
[flaml.automl.logger: 07-10 10:52:54] {2392} INFO -  at 6.5s,   estimator
xgboost's best error=0.0544,  best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:52:54] {2219} INFO - iteration 37, current
learner xgboost
[flaml.automl.logger: 07-10 10:52:54] {2392} INFO -  at 6.7s,   estimator
xgboost's best error=0.0544,  best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:52:54] {2219} INFO - iteration 38, current
learner xgboost
[flaml.automl.logger: 07-10 10:52:55] {2392} INFO -  at 7.0s,   estimator
xgboost's best error=0.0533,  best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:52:55] {2219} INFO - iteration 39, current
learner lgbm
[flaml.automl.logger: 07-10 10:52:55] {2392} INFO -  at 7.1s,   estimator lgbm's
best error=0.0512,     best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:52:55] {2219} INFO - iteration 40, current
learner xgboost
[flaml.automl.logger: 07-10 10:52:55] {2392} INFO -  at 7.3s,   estimator
xgboost's best error=0.0533,  best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:52:55] {2219} INFO - iteration 41, current
learner xgboost
[flaml.automl.logger: 07-10 10:52:57] {2392} INFO -  at 9.0s,   estimator
xgboost's best error=0.0533,  best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:52:57] {2219} INFO - iteration 42, current
learner lgbm
[flaml.automl.logger: 07-10 10:52:58] {2392} INFO -  at 10.4s,  estimator lgbm's
best error=0.0512,     best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:52:58] {2219} INFO - iteration 43, current
learner rf
[flaml.automl.logger: 07-10 10:52:58] {2392} INFO -  at 10.5s,  estimator rf's
best error=0.0921,       best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:52:58] {2219} INFO - iteration 44, current
learner extra_tree
[flaml.automl.logger: 07-10 10:52:58] {2392} INFO -  at 10.6s,  estimator
```

```
extra_tree's best error=0.1355,       best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:52:58] {2219} INFO - iteration 45, current
learner rf
[flaml.automl.logger: 07-10 10:52:59] {2392} INFO -  at 11.1s,  estimator rf's
best error=0.0649,       best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:52:59] {2219} INFO - iteration 46, current
learner rf
[flaml.automl.logger: 07-10 10:52:59] {2392} INFO -  at 11.7s,  estimator rf's
best error=0.0637,       best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:52:59] {2219} INFO - iteration 47, current
learner xgboost
[flaml.automl.logger: 07-10 10:53:00] {2392} INFO -  at 11.9s,  estimator
xgboost's best error=0.0533,  best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:00] {2219} INFO - iteration 48, current
learner lgbm
[flaml.automl.logger: 07-10 10:53:02] {2392} INFO -  at 14.4s,  estimator lgbm's
best error=0.0512,     best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:02] {2219} INFO - iteration 49, current
learner lgbm
[flaml.automl.logger: 07-10 10:53:02] {2392} INFO -  at 14.5s,  estimator lgbm's
best error=0.0512,     best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:02] {2219} INFO - iteration 50, current
learner xgboost
[flaml.automl.logger: 07-10 10:53:03] {2392} INFO -  at 15.3s,  estimator
xgboost's best error=0.0533,  best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:03] {2219} INFO - iteration 51, current
learner lgbm
[flaml.automl.logger: 07-10 10:53:04] {2392} INFO -  at 15.8s,  estimator lgbm's
best error=0.0512,     best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:04] {2219} INFO - iteration 52, current
learner lgbm
[flaml.automl.logger: 07-10 10:53:04] {2392} INFO -  at 16.3s,  estimator lgbm's
best error=0.0512,     best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:04] {2219} INFO - iteration 53, current
learner lgbm
[flaml.automl.logger: 07-10 10:53:04] {2392} INFO -  at 16.6s,  estimator lgbm's
best error=0.0512,     best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:04] {2219} INFO - iteration 54, current
learner lgbm
[flaml.automl.logger: 07-10 10:53:05] {2392} INFO -  at 17.3s,  estimator lgbm's
best error=0.0512,     best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:05] {2219} INFO - iteration 55, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 10:53:06] {2392} INFO -  at 18.1s,  estimator
xgb_limitdepth's best error=0.0555,   best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:06] {2219} INFO - iteration 56, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 10:53:06] {2392} INFO -  at 18.6s,  estimator
```

```
xgb_limitdepth's best error=0.0555,   best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:06] {2219} INFO - iteration 57, current
learner extra_tree
[flaml.automl.logger: 07-10 10:53:06] {2392} INFO -  at 18.8s,  estimator
extra_tree's best error=0.1025,       best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:06] {2219} INFO - iteration 58, current
learner extra_tree
[flaml.automl.logger: 07-10 10:53:07] {2392} INFO -  at 18.9s,  estimator
extra_tree's best error=0.1025,       best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:07] {2219} INFO - iteration 59, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 10:53:08] {2392} INFO -  at 20.2s,  estimator
xgb_limitdepth's best error=0.0541,   best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:08] {2219} INFO - iteration 60, current
learner lgbm
[flaml.automl.logger: 07-10 10:53:08] {2392} INFO -  at 20.8s,  estimator lgbm's
best error=0.0512,     best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:08] {2219} INFO - iteration 61, current
learner extra_tree
[flaml.automl.logger: 07-10 10:53:09] {2392} INFO -  at 20.9s,  estimator
extra_tree's best error=0.1025,       best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:09] {2219} INFO - iteration 62, current
learner lgbm
[flaml.automl.logger: 07-10 10:53:09] {2392} INFO -  at 21.4s,  estimator lgbm's
best error=0.0512,     best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:09] {2219} INFO - iteration 63, current
learner extra_tree
[flaml.automl.logger: 07-10 10:53:09] {2392} INFO -  at 21.6s,  estimator
extra_tree's best error=0.1025,       best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:09] {2219} INFO - iteration 64, current
learner extra_tree
[flaml.automl.logger: 07-10 10:53:09] {2392} INFO -  at 21.8s,  estimator
extra_tree's best error=0.1025,       best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:09] {2219} INFO - iteration 65, current
learner lgbm
[flaml.automl.logger: 07-10 10:53:10] {2392} INFO -  at 22.0s,  estimator lgbm's
best error=0.0512,     best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:10] {2219} INFO - iteration 66, current
learner extra_tree
[flaml.automl.logger: 07-10 10:53:10] {2392} INFO -  at 22.2s,  estimator
extra_tree's best error=0.1025,       best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:10] {2219} INFO - iteration 67, current
learner extra_tree
[flaml.automl.logger: 07-10 10:53:10] {2392} INFO -  at 22.5s,  estimator
extra_tree's best error=0.1025,       best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:10] {2219} INFO - iteration 68, current
learner xgboost
[flaml.automl.logger: 07-10 10:53:11] {2392} INFO -  at 22.9s,  estimator
```

```
xgboost's best error=0.0533,  best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:11] {2219} INFO - iteration 69, current
learner lgbm
[flaml.automl.logger: 07-10 10:53:13] {2392} INFO -  at 24.9s,  estimator lgbm's
best error=0.0512,     best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:13] {2219} INFO - iteration 70, current
learner extra_tree
[flaml.automl.logger: 07-10 10:53:13] {2392} INFO -  at 25.0s,  estimator
extra_tree's best error=0.0990,       best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:13] {2219} INFO - iteration 71, current
learner extra_tree
[flaml.automl.logger: 07-10 10:53:13] {2392} INFO -  at 25.2s,  estimator
extra_tree's best error=0.0990,       best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:13] {2219} INFO - iteration 72, current
learner xgboost
[flaml.automl.logger: 07-10 10:53:13] {2392} INFO -  at 25.4s,  estimator
xgboost's best error=0.0533,  best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:13] {2219} INFO - iteration 73, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 10:53:13] {2392} INFO -  at 25.7s,  estimator
xgb_limitdepth's best error=0.0541,   best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:13] {2219} INFO - iteration 74, current
learner xgboost
[flaml.automl.logger: 07-10 10:53:14] {2392} INFO -  at 26.1s,  estimator
xgboost's best error=0.0533,  best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:14] {2219} INFO - iteration 75, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 10:53:19] {2392} INFO -  at 31.2s,  estimator
xgb_limitdepth's best error=0.0524,   best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:19] {2219} INFO - iteration 76, current
learner lgbm
[flaml.automl.logger: 07-10 10:53:22] {2392} INFO -  at 34.5s,  estimator lgbm's
best error=0.0512,     best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:22] {2219} INFO - iteration 77, current
learner lgbm
[flaml.automl.logger: 07-10 10:53:22] {2392} INFO -  at 34.7s,  estimator lgbm's
best error=0.0512,     best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:22] {2219} INFO - iteration 78, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 10:53:28] {2392} INFO -  at 40.3s,  estimator
xgb_limitdepth's best error=0.0524,   best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:28] {2219} INFO - iteration 79, current
learner rf
[flaml.automl.logger: 07-10 10:53:28] {2392} INFO -  at 40.7s,  estimator rf's
best error=0.0637,       best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:28] {2219} INFO - iteration 80, current
learner lgbm
[flaml.automl.logger: 07-10 10:53:29] {2392} INFO -  at 40.9s,  estimator lgbm's
```

```
best error=0.0512,     best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:29] {2219} INFO - iteration 81, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 10:53:33] {2392} INFO -  at 45.0s,  estimator
xgb_limitdepth's best error=0.0524,   best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:33] {2219} INFO - iteration 82, current
learner rf
[flaml.automl.logger: 07-10 10:53:33] {2392} INFO -  at 45.6s,  estimator rf's
best error=0.0637,       best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:33] {2219} INFO - iteration 83, current
learner extra_tree
[flaml.automl.logger: 07-10 10:53:33] {2392} INFO -  at 45.8s,  estimator
extra_tree's best error=0.0990,       best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:33] {2219} INFO - iteration 84, current
learner extra_tree
[flaml.automl.logger: 07-10 10:53:34] {2392} INFO -  at 46.0s,  estimator
extra_tree's best error=0.0990,       best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:34] {2219} INFO - iteration 85, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 10:53:38] {2392} INFO -  at 50.2s,  estimator
xgb_limitdepth's best error=0.0524,   best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:38] {2219} INFO - iteration 86, current
learner xgboost
[flaml.automl.logger: 07-10 10:53:38] {2392} INFO -  at 50.5s,  estimator
xgboost's best error=0.0533,  best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:38] {2219} INFO - iteration 87, current
learner extra_tree
[flaml.automl.logger: 07-10 10:53:38] {2392} INFO -  at 50.6s,  estimator
extra_tree's best error=0.0983,       best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:38] {2219} INFO - iteration 88, current
learner lgbm
[flaml.automl.logger: 07-10 10:53:40] {2392} INFO -  at 52.0s,  estimator lgbm's
best error=0.0512,     best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:40] {2219} INFO - iteration 89, current
learner lgbm
[flaml.automl.logger: 07-10 10:53:40] {2392} INFO -  at 52.6s,  estimator lgbm's
best error=0.0512,     best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:40] {2219} INFO - iteration 90, current
learner lrl1
[flaml.automl.logger: 07-10 10:53:42] {2392} INFO -  at 54.0s,  estimator lrl1's
best error=0.0694,     best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:42] {2219} INFO - iteration 91, current
learner lrl1
[flaml.automl.logger: 07-10 10:53:43] {2392} INFO -  at 54.9s,  estimator lrl1's
best error=0.0694,     best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:43] {2219} INFO - iteration 92, current
learner lrl1
[flaml.automl.logger: 07-10 10:53:45] {2392} INFO -  at 57.8s,  estimator lrl1's
```

```
best error=0.0694,     best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:45] {2219} INFO - iteration 93, current
learner lrl1
[flaml.automl.logger: 07-10 10:53:47] {2392} INFO -  at 59.1s,  estimator lrl1's
best error=0.0693,     best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:47] {2219} INFO - iteration 94, current
learner xgboost
[flaml.automl.logger: 07-10 10:53:47] {2392} INFO -  at 59.4s,  estimator
xgboost's best error=0.0533,  best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:47] {2219} INFO - iteration 95, current
learner xgboost
[flaml.automl.logger: 07-10 10:53:47] {2392} INFO -  at 59.6s,  estimator
xgboost's best error=0.0533,  best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:47] {2219} INFO - iteration 96, current
learner lgbm
[flaml.automl.logger: 07-10 10:53:48] {2392} INFO -  at 60.1s,  estimator lgbm's
best error=0.0512,     best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:48] {2219} INFO - iteration 97, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 10:53:53] {2392} INFO -  at 65.5s,  estimator
xgb_limitdepth's best error=0.0524,   best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:53] {2219} INFO - iteration 98, current
learner rf
[flaml.automl.logger: 07-10 10:53:54] {2392} INFO -  at 66.2s,  estimator rf's
best error=0.0637,       best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:54] {2219} INFO - iteration 99, current
learner xgboost
[flaml.automl.logger: 07-10 10:53:54] {2392} INFO -  at 66.5s,  estimator
xgboost's best error=0.0533,  best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:54] {2219} INFO - iteration 100, current
learner rf
[flaml.automl.logger: 07-10 10:53:55] {2392} INFO -  at 67.2s,  estimator rf's
best error=0.0541,       best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:55] {2219} INFO - iteration 101, current
learner rf
[flaml.automl.logger: 07-10 10:53:55] {2392} INFO -  at 67.8s,  estimator rf's
best error=0.0541,       best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:55] {2219} INFO - iteration 102, current
learner xgboost
[flaml.automl.logger: 07-10 10:53:56] {2392} INFO -  at 68.1s,  estimator
xgboost's best error=0.0533,  best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:56] {2219} INFO - iteration 103, current
learner rf
[flaml.automl.logger: 07-10 10:53:57] {2392} INFO -  at 68.8s,  estimator rf's
best error=0.0541,       best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:57] {2219} INFO - iteration 104, current
learner lgbm
[flaml.automl.logger: 07-10 10:53:57] {2392} INFO -  at 69.0s,  estimator lgbm's
```

```
best error=0.0512,     best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:57] {2219} INFO - iteration 105, current
learner rf
[flaml.automl.logger: 07-10 10:53:57] {2392} INFO -  at 69.8s,  estimator rf's
best error=0.0541,       best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:57] {2219} INFO - iteration 106, current
learner rf
[flaml.automl.logger: 07-10 10:53:58] {2392} INFO -  at 70.2s,  estimator rf's
best error=0.0541,       best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:58] {2219} INFO - iteration 107, current
learner rf
[flaml.automl.logger: 07-10 10:53:59] {2392} INFO -  at 71.2s,  estimator rf's
best error=0.0541,       best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:59] {2219} INFO - iteration 108, current
learner xgboost
[flaml.automl.logger: 07-10 10:53:59] {2392} INFO -  at 71.5s,  estimator
xgboost's best error=0.0533,  best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:53:59] {2219} INFO - iteration 109, current
learner rf
[flaml.automl.logger: 07-10 10:54:00] {2392} INFO -  at 72.6s,  estimator rf's
best error=0.0541,       best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:54:00] {2219} INFO - iteration 110, current
learner extra_tree
[flaml.automl.logger: 07-10 10:54:01] {2392} INFO -  at 72.9s,  estimator
extra_tree's best error=0.0973,       best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:54:01] {2219} INFO - iteration 111, current
learner rf
[flaml.automl.logger: 07-10 10:54:01] {2392} INFO -  at 73.5s,  estimator rf's
best error=0.0541,       best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:54:01] {2219} INFO - iteration 112, current
learner lgbm
[flaml.automl.logger: 07-10 10:54:03] {2392} INFO -  at 75.7s,  estimator lgbm's
best error=0.0512,     best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:54:03] {2219} INFO - iteration 113, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 10:54:10] {2392} INFO -  at 82.1s,  estimator
xgb_limitdepth's best error=0.0524,   best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:54:10] {2219} INFO - iteration 114, current
learner rf
[flaml.automl.logger: 07-10 10:54:10] {2392} INFO -  at 82.8s,  estimator rf's
best error=0.0541,       best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:54:10] {2219} INFO - iteration 115, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 10:54:14] {2392} INFO -  at 85.9s,  estimator
xgb_limitdepth's best error=0.0524,   best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:54:14] {2219} INFO - iteration 116, current
learner rf
[flaml.automl.logger: 07-10 10:54:14] {2392} INFO -  at 86.7s,  estimator rf's
```

```
best error=0.0541,       best estimator lgbm's best error=0.0512
[flaml.automl.logger: 07-10 10:54:14] {2219} INFO - iteration 117, current
learner lgbm
[flaml.automl.logger: 07-10 10:54:16] {2392} INFO -  at 88.8s,  estimator lgbm's
best error=0.0510,     best estimator lgbm's best error=0.0510
[flaml.automl.logger: 07-10 10:54:16] {2219} INFO - iteration 118, current
learner extra_tree
[flaml.automl.logger: 07-10 10:54:17] {2392} INFO -  at 88.9s,  estimator
extra_tree's best error=0.0973,       best estimator lgbm's best error=0.0510
[flaml.automl.logger: 07-10 10:54:17] {2219} INFO - iteration 119, current
learner rf
[flaml.automl.logger: 07-10 10:54:18] {2392} INFO -  at 90.2s,  estimator rf's
best error=0.0539,       best estimator lgbm's best error=0.0510
[flaml.automl.logger: 07-10 10:54:18] {2219} INFO - iteration 120, current
learner lgbm
[flaml.automl.logger: 07-10 10:54:18] {2392} INFO -  at 90.6s,  estimator lgbm's
best error=0.0510,     best estimator lgbm's best error=0.0510
[flaml.automl.logger: 07-10 10:54:18] {2219} INFO - iteration 121, current
learner extra_tree
[flaml.automl.logger: 07-10 10:54:18] {2392} INFO -  at 90.7s,  estimator
extra_tree's best error=0.0957,       best estimator lgbm's best error=0.0510
[flaml.automl.logger: 07-10 10:54:18] {2219} INFO - iteration 122, current
learner extra_tree
[flaml.automl.logger: 07-10 10:54:19] {2392} INFO -  at 91.0s,  estimator
extra_tree's best error=0.0957,       best estimator lgbm's best error=0.0510
[flaml.automl.logger: 07-10 10:54:19] {2219} INFO - iteration 123, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 10:54:19] {2392} INFO -  at 91.8s,  estimator
xgb_limitdepth's best error=0.0524,   best estimator lgbm's best error=0.0510
[flaml.automl.logger: 07-10 10:54:19] {2219} INFO - iteration 124, current
learner extra_tree
[flaml.automl.logger: 07-10 10:54:20] {2392} INFO -  at 92.0s,  estimator
extra_tree's best error=0.0957,       best estimator lgbm's best error=0.0510
[flaml.automl.logger: 07-10 10:54:20] {2219} INFO - iteration 125, current
learner lgbm
[flaml.automl.logger: 07-10 10:54:23] {2392} INFO -  at 95.1s,  estimator lgbm's
best error=0.0510,     best estimator lgbm's best error=0.0510
[flaml.automl.logger: 07-10 10:54:23] {2219} INFO - iteration 126, current
learner lgbm
[flaml.automl.logger: 07-10 10:54:24] {2392} INFO -  at 96.6s,  estimator lgbm's
best error=0.0500,     best estimator lgbm's best error=0.0500
[flaml.automl.logger: 07-10 10:54:24] {2219} INFO - iteration 127, current
learner lgbm
[flaml.automl.logger: 07-10 10:54:26] {2392} INFO -  at 98.4s,  estimator lgbm's
best error=0.0500,     best estimator lgbm's best error=0.0500
[flaml.automl.logger: 07-10 10:54:26] {2219} INFO - iteration 128, current
learner lgbm
[flaml.automl.logger: 07-10 10:54:27] {2392} INFO -  at 99.7s,  estimator lgbm's
```

```
best error=0.0500,     best estimator lgbm's best error=0.0500
[flaml.automl.logger: 07-10 10:54:27] {2219} INFO - iteration 129, current
learner lgbm
[flaml.automl.logger: 07-10 10:54:28] {2392} INFO -  at 100.6s, estimator lgbm's
best error=0.0500,     best estimator lgbm's best error=0.0500
[flaml.automl.logger: 07-10 10:54:28] {2219} INFO - iteration 130, current
learner xgboost
[flaml.automl.logger: 07-10 10:54:29] {2392} INFO -  at 100.9s, estimator
xgboost's best error=0.0533,  best estimator lgbm's best error=0.0500
[flaml.automl.logger: 07-10 10:54:29] {2219} INFO - iteration 131, current
learner lgbm
[flaml.automl.logger: 07-10 10:54:34] {2392} INFO -  at 106.2s, estimator lgbm's
best error=0.0500,     best estimator lgbm's best error=0.0500
[flaml.automl.logger: 07-10 10:54:34] {2219} INFO - iteration 132, current
learner lgbm
[flaml.automl.logger: 07-10 10:54:42] {2392} INFO -  at 114.6s, estimator lgbm's
best error=0.0500,     best estimator lgbm's best error=0.0500
[flaml.automl.logger: 07-10 10:54:42] {2219} INFO - iteration 133, current
learner extra_tree
[flaml.automl.logger: 07-10 10:54:42] {2392} INFO -  at 114.7s, estimator
extra_tree's best error=0.0957,       best estimator lgbm's best error=0.0500
[flaml.automl.logger: 07-10 10:54:42] {2219} INFO - iteration 134, current
learner lgbm
[flaml.automl.logger: 07-10 10:54:43] {2392} INFO -  at 115.1s, estimator lgbm's
best error=0.0500,     best estimator lgbm's best error=0.0500
[flaml.automl.logger: 07-10 10:54:43] {2219} INFO - iteration 135, current
learner lgbm
[flaml.automl.logger: 07-10 10:54:52] {2392} INFO -  at 124.5s, estimator lgbm's
best error=0.0500,     best estimator lgbm's best error=0.0500
[flaml.automl.logger: 07-10 10:54:52] {2219} INFO - iteration 136, current
learner xgboost
[flaml.automl.logger: 07-10 10:54:53] {2392} INFO -  at 125.0s, estimator
xgboost's best error=0.0533,  best estimator lgbm's best error=0.0500
[flaml.automl.logger: 07-10 10:54:53] {2219} INFO - iteration 137, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 10:55:23] {2392} INFO -  at 155.0s, estimator
xgb_limitdepth's best error=0.0524,   best estimator lgbm's best error=0.0500
[flaml.automl.logger: 07-10 10:55:23] {2219} INFO - iteration 138, current
learner xgboost
[flaml.automl.logger: 07-10 10:55:23] {2392} INFO -  at 155.2s, estimator
xgboost's best error=0.0533,  best estimator lgbm's best error=0.0500
[flaml.automl.logger: 07-10 10:55:23] {2219} INFO - iteration 139, current
learner lgbm
[flaml.automl.logger: 07-10 10:55:23] {2392} INFO -  at 155.5s, estimator lgbm's
best error=0.0500,     best estimator lgbm's best error=0.0500
[flaml.automl.logger: 07-10 10:55:23] {2219} INFO - iteration 140, current
learner extra_tree
[flaml.automl.logger: 07-10 10:55:23] {2392} INFO -  at 155.7s, estimator
```

```
extra_tree's best error=0.0957,       best estimator lgbm's best error=0.0500
[flaml.automl.logger: 07-10 10:55:23] {2219} INFO - iteration 141, current
learner lgbm
[flaml.automl.logger: 07-10 10:55:28] {2392} INFO -  at 159.8s, estimator lgbm's
best error=0.0500,     best estimator lgbm's best error=0.0500
[flaml.automl.logger: 07-10 10:55:28] {2219} INFO - iteration 142, current
learner extra_tree
[flaml.automl.logger: 07-10 10:55:28] {2392} INFO -  at 160.1s, estimator
extra_tree's best error=0.0957,       best estimator lgbm's best error=0.0500
[flaml.automl.logger: 07-10 10:55:28] {2219} INFO - iteration 143, current
learner lgbm
[flaml.automl.logger: 07-10 10:55:28] {2392} INFO -  at 160.7s, estimator lgbm's
best error=0.0500,     best estimator lgbm's best error=0.0500
[flaml.automl.logger: 07-10 10:55:28] {2219} INFO - iteration 144, current
learner extra_tree
[flaml.automl.logger: 07-10 10:55:29] {2392} INFO -  at 160.9s, estimator
extra_tree's best error=0.0957,       best estimator lgbm's best error=0.0500
[flaml.automl.logger: 07-10 10:55:29] {2219} INFO - iteration 145, current
learner xgboost
[flaml.automl.logger: 07-10 10:55:29] {2392} INFO -  at 161.2s, estimator
xgboost's best error=0.0533,  best estimator lgbm's best error=0.0500
[flaml.automl.logger: 07-10 10:55:29] {2219} INFO - iteration 146, current
learner xgboost
[flaml.automl.logger: 07-10 10:55:29] {2392} INFO -  at 161.4s, estimator
xgboost's best error=0.0533,  best estimator lgbm's best error=0.0500
[flaml.automl.logger: 07-10 10:55:29] {2219} INFO - iteration 147, current
learner lgbm
[flaml.automl.logger: 07-10 10:55:32] {2392} INFO -  at 164.2s, estimator lgbm's
best error=0.0500,     best estimator lgbm's best error=0.0500
[flaml.automl.logger: 07-10 10:55:32] {2219} INFO - iteration 148, current
learner lgbm
[flaml.automl.logger: 07-10 10:55:33] {2392} INFO -  at 165.2s, estimator lgbm's
best error=0.0500,     best estimator lgbm's best error=0.0500
[flaml.automl.logger: 07-10 10:55:33] {2219} INFO - iteration 149, current
learner lgbm
[flaml.automl.logger: 07-10 10:55:38] {2392} INFO -  at 170.1s, estimator lgbm's
best error=0.0500,     best estimator lgbm's best error=0.0500
[flaml.automl.logger: 07-10 10:55:38] {2219} INFO - iteration 150, current
learner lgbm
[flaml.automl.logger: 07-10 10:55:39] {2392} INFO -  at 170.9s, estimator lgbm's
best error=0.0500,     best estimator lgbm's best error=0.0500
[flaml.automl.logger: 07-10 10:55:39] {2219} INFO - iteration 151, current
learner lgbm
[flaml.automl.logger: 07-10 10:55:40] {2392} INFO -  at 172.7s, estimator lgbm's
best error=0.0496,     best estimator lgbm's best error=0.0496
[flaml.automl.logger: 07-10 10:55:40] {2219} INFO - iteration 152, current
learner lgbm
[flaml.automl.logger: 07-10 10:55:45] {2392} INFO -  at 177.3s, estimator lgbm's
```

```
best error=0.0496,     best estimator lgbm's best error=0.0496
[flaml.automl.logger: 07-10 10:55:45] {2219} INFO - iteration 153, current
learner xgboost
[flaml.automl.logger: 07-10 10:55:45] {2392} INFO -  at 177.6s, estimator
xgboost's best error=0.0533,  best estimator lgbm's best error=0.0496
[flaml.automl.logger: 07-10 10:55:45] {2219} INFO - iteration 154, current
learner xgboost
[flaml.automl.logger: 07-10 10:55:45] {2392} INFO -  at 177.8s, estimator
xgboost's best error=0.0533,  best estimator lgbm's best error=0.0496
[flaml.automl.logger: 07-10 10:55:45] {2219} INFO - iteration 155, current
learner lgbm
[flaml.automl.logger: 07-10 10:55:46] {2392} INFO -  at 178.7s, estimator lgbm's
best error=0.0496,     best estimator lgbm's best error=0.0496
[flaml.automl.logger: 07-10 10:55:46] {2219} INFO - iteration 156, current
learner lgbm
[flaml.automl.logger: 07-10 10:55:50] {2392} INFO -  at 181.9s, estimator lgbm's
best error=0.0496,     best estimator lgbm's best error=0.0496
[flaml.automl.logger: 07-10 10:55:50] {2219} INFO - iteration 157, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 10:55:51] {2392} INFO -  at 182.9s, estimator
xgb_limitdepth's best error=0.0524,   best estimator lgbm's best error=0.0496
[flaml.automl.logger: 07-10 10:55:51] {2219} INFO - iteration 158, current
learner xgboost
[flaml.automl.logger: 07-10 10:55:51] {2392} INFO -  at 183.3s, estimator
xgboost's best error=0.0533,  best estimator lgbm's best error=0.0496
[flaml.automl.logger: 07-10 10:55:51] {2219} INFO - iteration 159, current
learner lgbm
[flaml.automl.logger: 07-10 10:55:52] {2392} INFO -  at 184.7s, estimator lgbm's
best error=0.0496,     best estimator lgbm's best error=0.0496
[flaml.automl.logger: 07-10 10:55:52] {2219} INFO - iteration 160, current
learner lgbm
[flaml.automl.logger: 07-10 10:55:55] {2392} INFO -  at 187.6s, estimator lgbm's
best error=0.0496,     best estimator lgbm's best error=0.0496
[flaml.automl.logger: 07-10 10:55:55] {2219} INFO - iteration 161, current
learner extra_tree
[flaml.automl.logger: 07-10 10:55:56] {2392} INFO -  at 187.9s, estimator
extra_tree's best error=0.0957,       best estimator lgbm's best error=0.0496
[flaml.automl.logger: 07-10 10:55:56] {2219} INFO - iteration 162, current
learner lgbm
[flaml.automl.logger: 07-10 10:55:57] {2392} INFO -  at 189.3s, estimator lgbm's
best error=0.0496,     best estimator lgbm's best error=0.0496
[flaml.automl.logger: 07-10 10:55:57] {2219} INFO - iteration 163, current
learner xgboost
[flaml.automl.logger: 07-10 10:55:57] {2392} INFO -  at 189.5s, estimator
xgboost's best error=0.0533,  best estimator lgbm's best error=0.0496
[flaml.automl.logger: 07-10 10:55:57] {2219} INFO - iteration 164, current
learner xgb_limitdepth
[flaml.automl.logger: 07-10 10:56:08] {2392} INFO -  at 199.9s, estimator
```

```
xgb_limitdepth's best error=0.0524,   best estimator lgbm's best error=0.0496
[flaml.automl.logger: 07-10 10:56:09] {2628} INFO - retrain lgbm for 1.8s
[flaml.automl.logger: 07-10 10:56:09] {2631} INFO - retrained model:
LGBMClassifier(colsample_bytree=0.9428321760589469,
               learning_rate=0.10118180974643463, max_bin=255,
               min_child_samples=58, n_estimators=1, n_jobs=-1, num_leaves=19,
               reg_alpha=5.358102048300909, reg_lambda=0.28970030167004707,
               verbose=-1)
[flaml.automl.logger: 07-10 10:56:09] {1931} INFO - fit succeeded
[flaml.automl.logger: 07-10 10:56:09] {1932} INFO - Time taken to find the best
model: 172.72211503982544
```

[70]:
```
from sklearn.metrics import roc_auc_score, accuracy_score
pred=automl.predict(X_test)
#y_scores = automl.decision_function(X_test)
acc_automl = accuracy_score(y_test,pred)
score=automl.predict_proba(X_test)
y_score=score[:,1]
roc_automl=roc_auc_score(y_test,y_score)
```

[ ]:
```
import numpy as np
import plotly.graph_objects as go
from functools import reduce
from itertools import product
from IPython.display import Image
SUB = str.maketrans("0123456789", "      ")
SUP = str.maketrans("0123456789", " ¹²³    ")
z=[ [np.round(results['KNN'],3),np.round(results['LOF'],3),np.
 ↪round(results['HBOS'],3),
     np.round(results['IForest'],3),np.round(results['PCA'],3),np.
 ↪round(results['MCD'],3),
    np.round(results['OCSVM'],3),np.round(results['KDE'],3),np.
 ↪round(roc_automl,3)],


   [np.round(accuracy['KNN'],3),
    np.round(accuracy['LOF'],3),np.round(accuracy['HBOS'],3),np.
 ↪round(accuracy['IForest'],3),
    np.round(accuracy['PCA'],3),np.round(accuracy['MCD'],3),np.
 ↪round(accuracy['OCSVM'],3),
    np.round(accuracy['KDE'],3),np.round(acc_automl,3)]]
x=['<b>KNN</b>', '<b>LOF</b>', '<b>HBOS</b>', '<b>IForest</b>', '<b>PCA</
 ↪b>','<b>MCD</b>',
   '<b>OCSVM</b>','<b>KDE</b>','<b>FLAML</b>']
y=['<b>ROC AUC</b>','<b>Accuracy</b>']

def get_anno_text(z_value):
```

```
    annotations=[]
    a, b = len(z_value), len(z_value[0])
    flat_z = reduce(lambda x,y: x+y, z_value) # z_value.flat if you deal with␣
 ↪numpy
    coords = product(range(a), range(b))
    for pos, elem in zip(coords, flat_z):
        annotations.append({'font': {'color': 'black'},
                    'showarrow': False,
                    'text': str(elem),
                    'x': pos[1],
                    'y': pos[0],
                        'font.size':22   })
    return annotations

fig = go.Figure(data=go.Heatmap(
                    z=z,
                    x=x,
                    y=y,
                    hoverongaps = True, colorscale ='turbid',
    opacity=0.6,colorbar=dict(tickfont=dict(size=20)) ))#matter#

fig.update_layout(title={'text': "",
        'y':0.8,
        'x':0.5,
        'xanchor': 'center',
        'yanchor': 'top'},
          plot_bgcolor='rgba(0,0,0,0)',
    annotations = get_anno_text(z),
                width=1300,
height=250,xaxis={'side': 'top'},margin=dict(l=20, r=20, t=20, b=20))

fig.update_xaxes(tickfont = dict(size=24),linewidth=0.1, linecolor='black',

                 mirror=True)
fig.update_yaxes(tickfont = dict(size=24),linewidth=0.1, linecolor='black',

                 mirror=True)
fig.write_image("table2b.png",engine="kaleido")
#plt.savefig("table2a.pdf", format="pdf", bbox_inches="tight")
fig.show()
Image('table2c.png')
```

[ ]:

[ ]:

[ ]:

KNN(algorithm='auto', contamination=0.1, leaf_size=10, method='mean', metric='euclidean', metric_params=None, n_jobs=1, n_neighbors=5, p=2, radius=1.0)

Best model for LOF: LOF(algorithm='ball_tree', contamination=0.01, leaf_size=30, metric='manhattan', metric_params=None, n_jobs=1, n_neighbors=20, novelty=True, p=2)

Best model for HBOS: HBOS(alpha=0.9, contamination=0.01, n_bins=40, tol=0.5)

Best model for IForest: IForest(behaviour='new', bootstrap=False, contamination=0.15, max_features=0.5, max_samples=1.0, n_estimators=50, n_jobs=1, random_state=None, verbose=0)

Best model for PCA: PCA(contamination=0.1, copy=True, iterated_power='auto', n_components=2, n_selected_components=None, random_state=None, standardization=True, svd_solver='auto', tol=0.0, weighted=True, whiten=True)

Best model for MCD: MCD(assume_centered=False, contamination=0.01, random_state=None, store_precision=True, support_fraction=None)

Best model for OCSVM: OCSVM(cache_size=200, coef0=0.0, contamination=0.1, degree=3, gamma='scale', kernel='rbf', max_iter=-1, nu=0.01, shrinking=True, tol=0.001, verbose=False)

Best model for KDE: KDE(algorithm='auto', bandwidth=1.0, contamination=0.01, leaf_size=30, metric='minkowski', metric_params=None)

ROC AUC Scores: {'KNN': 0.7673781249999999, 'LOF': 0.770096875, 'HBOS': 0.7543078125, 'IForest': 0.8742593750000001, 'PCA': 0.6861906249999999, 'MCD': 0.9199875000000001, 'OCSVM': 0.649525, 'KDE': 0.54524375}

26.1 *2. How consistent are SHAP explanations for different anomaly detectors?*

Where anomaly detectors agree on predictions, do they give rise to similar SHAP value explanations? How about when they disagree?

[link text] (https://)## *3. How does missing data impact anomaly detection?* Are different anomaly detection algorithms better suited for datasets where there are more missing values?

[ ]: