	House prices  https://www.kaggle.com/competitions/house-prices-advanced-regression-techniques  Тренировочное упражнение, цель которого предсказать стоимость дома, основываясь на довольно большом количестве параметров.
In [39]:	<pre>import numpy as np import pandas as pd import matplotlib.pyplot as plt import pathlib pathlib.Path().resolve() import sklearn from sklearn.preprocessing import LabelBinarizer from sklearn.preprocessing import LabelEncoder from sklearn.preprocessing import MinMaxScaler from sklearn.model_selection import train_test_split</pre>
	<pre>import tensorflow as tf import tensorflow.keras as keras from tensorflow.keras.models import Sequential, Model from tensorflow.keras.layers import Dropout, Dense, GRU  import optuna from optuna import Trial, visualization from optuna.samplers import TPESampler from optuna.samplers import CmaEsSampler</pre> from xgboost import XGBRegressor
	<pre>from sklearn.model_selection import cross_val_score  from tensorflow.keras.callbacks import ModelCheckpoint from sklearn.metrics import r2_score from sklearn.metrics import mean_squared_error from sklearn.metrics import mean_absolute_error from sklearn.model_selection import KFold import warnings warnings.filterwarnings('ignore')</pre>
In [40]:	1.Обработка параметров.  Загружаем и обрабатываем параметры. Всего параметров 79(исключая сами цены на дом). Полное описание каждого из них приводится по ссылке, в основном это параметры, относящиеся к качеству дома и окружающей его земли, такие как материал, из которого сделана крыша, размер лужайки у дома, есть бассейн и т.д. Детально разбираться и останавливаться в данном случае на каждом параметре не будем.   train = pd.read_csv("./data/train.csv", index_col= 0) train.head()
Out[40]:	MSSubClass         MSZoning         LotFrontage         LotArea         Street         Alley         LotShape         LandContour         Utilities         LotConfig          PoolArea         PoolQC         Fence           1         60         RL         65.0         8450         Pave         NaN         Reg         Lvl         AllPub         Inside          0         NaN         Na           2         20         RL         80.0         9600         Pave         NaN         Reg         Lvl         AllPub         FR2          0         NaN         Na           3         60         RL         68.0         11250         Pave         NaN         IR1         Lvl         AllPub         Inside          0         NaN         Na           4         70         RL         60.0         9550         Pave         NaN         IR1         Lvl         AllPub         Corner          0         NaN         Na           5         60         RL         84.0         14260         Pave         NaN         IR1         Lvl         AllPub         FR2          0         NaN         Na
In [41]:	5 rows × 80 columns  Необходимо проверить параметры на пропуски данных, а также выбрать те параметры, которые не является числовыми, для их дальнейшего кодирования в числовом виде. Начнем с параметров, которые имеют целочисленные значения изначально
Out[41]:	MSSubClass         LotArea         OverallQual         OverallCond         YearBuilt         YearRemodAdd         BsmtFinSF1         BsmtFinSF2         BsmtUnfSF         TotalBsmtSF          N           Id         60         8450         7         5         2003         2003         706         0         150         856            2         20         9600         6         8         1976         1976         978         0         284         1262            3         60         11250         7         5         2001         2002         486         0         434         920
In [42]:	4       70       9550       7       5       1915       1970       216       0       540       756          5       60       14260       8       5       2000       2000       655       0       490       1145          5 rows × 34 columns         Видим, что пропусков нет и данные в числовом виде, значит оставляем их в покое и идём проверять числа с плавающей запятой:         dffloat = train.loc[:, train.dtypes == np.float64]         print (dffloat.isnull().any())
Out[42]:	<pre>LotFrontage True MasVnrArea True GarageYrBlt True dtype: bool</pre> LotFrontage MasVnrArea GarageYrBlt  Id  1 65.0 196.0 2003.0
	2       80.0       0.0       1976.0         3       68.0       162.0       2001.0         4       60.0       0.0       1998.0         5       84.0       350.0       2000.0    Видим, что есть пропуски. Заполняем их средним значением. Снова проверяем на пропуски:
In [43]:	dffloat.fillna(dffloat.mean(),inplace= <b>True</b> ) print(dffloat.isnull().any())  LotFrontage False MasVnrArea False GarageYrBlt False dtype: bool  Теперь обрабатываем параметры, содержащие текст. Стоит отметить, что в данном случае NaN у некоторых параметров означает не отсутствие информации о данном параметре. Допустим - для параметра "Alley" значение NaN означает об отсутствии у дома доступа к аллее. Так как эти параметры и значения сами по себе несут смысловую нагрузку, выкидывать их не имеет смысла,
In [44]: Out[44]:	поэтому мы просто заменяем значение NaN(Not a Number) на текстовое NA(Not Avialable), т.к. в оригинальном виде NaN не является текстом и кодировать его не получится.   dfobj = train.loc[:, train.dtypes == np.object] dfobj = dfobj.replace(np.NaN,'NA') dfobj.head()  MSZoning Street Alley LotShape LandContour Utilities LotConfig LandSlope Neighborhood Condition1 GarageType GarageF Id
	1RLPaveNARegLvIAllPubInsideGtICollgCrNormAttchd2RLPaveNARegLvIAllPubFR2GtIVeenkerFeedrAttchd3RLPaveNAIR1LvIAllPubInsideGtICollgCrNormAttchd4RLPaveNAIR1LvIAllPubCornerGtICrawforNormDetchd5RLPaveNAIR1LvIAllPubFR2GtINoRidgeNormAttchd5rows × 43 columns
<pre>In [45]: Out[45]:</pre>	Кодируем при помощи LabelEncoder'a:  dfobj = dfobj.apply(LabelEncoder().fit_transform) dfobj.head()  MSZoning Street Alley LotShape LandContour Utilities LotConfig LandSlope Neighborhood Condition1 GarageType GarageF  ld  1 3 1 1 3 3 3 0 4 0 5 2 1
	2       3       1       1       3       3       0       2       0       24       1        1         3       3       1       1       0       3       0       4       0       5       2        1         4       3       1       1       0       3       0       0       0       6       2        5         5       3       1       1       0       3       0       2       0       15       2        1            5 rows × 43 columns            Соединяем все данные вместе
In [46]: Out[46]:	X = pd.concat([dfint,dffloat,dfobj],axis=1)   X.head()
In [47]:	4       70       9550       7       5       1915       1970       216       0       540       756          5       60       14260       8       5       2000       2000       655       0       490       1145          5 гоws × 80 соlumns         Выделяем входные и выходные данные:
Out[47]:	Id 1
In [48]:	Ha всякий случай весь процесс рассоединения, обработки и соединения данных можно выполнить при помощи следующей функции, то есть в пару строк:  def prepare_data(dataset):     dfint = dataset.loc[:, dataset.dtypes == np.int64]     dffloat = dataset.loc[:, dataset.dtypes == np.float64]     dffloat.fillna(dffloat.mean(),inplace=True)     dfobj = dataset.loc[:, dataset.dtypes == np.object]     dfobj = dfobj.replace(np.NaN,'NA')     dfobj = dfobj.apply(LabelEncoder().fit_transform)     X = pd.concat([dfint,dffloat,dfobj],axis=1)
In [49]:	return X         Делим данные на тестовую и обучающую выборку как 20%/80%, нормируем данные при помощи библиотечного скейлера для входных данных и деления на среднее при помощи выходных данных:         train_X, test_X, train_Y, test_Y = train_test_split(X_,Y_,test_size=0.2, random_state=1)         scaler_X = MinMaxScaler()         X_transformed = scaler_X.fit_transform(train_X)         test_X transformed = scaler_X.fit_transform(test_X)
	scaler_Y = np.mean(np.mean(train_Y)) #MinMaxScaler() Y_transformed = train_Y/scaler_Y##scaler_Y.fit_transform(np.array(train_Y).reshape(-1,1)) test_Y_transformed = test_Y/scaler_Y##scaler_Y.transform(np.array(test_Y))  Будем строить модель регрессии при помощи XGBoost Regressora. Для этого нужно определить его гиперпараметры, такие как число дереьев, их глубина, шаг обучения и т.д. В данном случае будем искать оптимальные гиперпараметры при помощи байесовского подхода:
In [51]:	<pre>2.Обучение модели  def objective(trial: Trial, X, Y, Xt, Yt) -&gt; float:      param={</pre>
In [19]:	<pre>model.fit(X,Y)  return cross_val_score(model,Xt,Yt).mean()  study=optuna.create_study(direction='maximize',sampler=TPESampler()) #TPESampler()) study.optimize(lambda trial:objective(trial,X_transformed,Y_transformed,test_X_transformed,test_Y_transformed),n_trials=150,n_jobs=4)  [I 2022-03-29 17:03:12,780] A new study created in memory with name: no-name-323da76a-6a6c-471d-9303-dfaf113a9cf5</pre>
	<pre>[I 2022-03-29 17:03:19,140] Trial 2 finished with value: 0.3172454894871465 and parameters: {'n_estim ators': 239, 'max_depth': 2, 'gamma': 5, 'learning_rate': 0.01221219718492138}. Best is trial 2 with value: 0.3172454894871465. [I 2022-03-29 17:03:31,701] Trial 1 finished with value: 0.08582768858301437 and parameters: {'n_estimators': 403, 'max_depth': 4, 'gamma': 11, 'learning_rate': 0.014437758548444622}. Best is trial 2 with value: 0.3172454894871465. [I 2022-03-29 17:03:33,750] Trial 3 finished with value: 0.33429462460402204 and parameters: {'n_estimators': 820, 'max_depth': 2, 'gamma': 5, 'learning_rate': 0.04026847735242661}. Best is trial 3 with value: 0.33429462460402204. [I 2022-03-29 17:03:42,330] Trial 0 finished with value: 0.29647307663059813 and parameters: {'n_estimators': 354, 'max_depth': 7, 'gamma': 6, 'learning_rate': 0.03930752090498216}. Best is trial 3 with</pre>
	<pre>value: 0.33429462460402204. [I 2022-03-29 17:03:43,946] Trial 5 finished with value: 0.16447479118898337 and parameters: {'n_esti mators': 810, 'max_depth': 1, 'gamma': 8, 'learning_rate': 0.04017677485356627}. Best is trial 3 with value: 0.33429462460402204. [I 2022-03-29 17:03:53,571] Trial 7 finished with value: 0.5015289450059657 and parameters: {'n_estim ators': 257, 'max_depth': 4, 'gamma': 3, 'learning_rate': 0.01331193744123117}. Best is trial 7 with value: 0.5015289450059657. [I 2022-03-29 17:04:00,829] Trial 9 finished with value: 0.3923154137240414 and parameters: {'n_estim ators': 472, 'max_depth': 1, 'gamma': 1, 'learning_rate': 0.05953142926960262}. Best is trial 7 with value: 0.5015289450059657. [I 2022-03-29 17:04:11,301] Trial 6 finished with value: 0.22510013892571168 and parameters: {'n_estim ators': 472, 'data depth': 1, 'gamma': 1, 'learning_rate': 0.05953142926960262}.</pre>
	mators': 322, 'max_depth': 10, 'gamma': 7, 'learning_rate': 0.01244673594275996}. Best is trial 7 wit h value: 0.5015289450059657.  [I 2022-03-29 17:04:14,579] Trial 11 finished with value: -0.004334535348571089 and parameters: {'n_e stimators': 502, 'max_depth': 0, 'gamma': 10, 'learning_rate': 0.012839115613396615}. Best is trial 7 with value: 0.5015289450059657.  [I 2022-03-29 17:04:19,486] Trial 8 finished with value: 0.17559475051673 and parameters: {'n_estimat ors': 306, 'max_depth': 10, 'gamma': 8, 'learning_rate': 0.009616936171881309}. Best is trial 7 with value: 0.5015289450059657.  [I 2022-03-29 17:04:29,811] Trial 10 finished with value: 0.2828243063727759 and parameters: {'n_estimators': 672, 'max_depth': 4, 'gamma': 6, 'learning_rate': 0.014167665823298323}. Best is trial 7 with value: 0.5015289450059657.  [I 2022-03-29 17:04:33,067] Trial 4 finished with value: 0.4296084743966924 and parameters: {'n estimators': 672, 'max_depth': 4, 'gamma': 6, 'learning_rate': 0.4296084743966924 and parameters: {'n estimators': 672, 'max_depth': 10, 'gamma': 6, 'learning_rate': 0.4296084743966924 and parameters: {'n estimators': 672, 'max_depth': 10, 'gamma': 6, 'learning_rate': 0.4296084743966924 and parameters: {'n estimators': 672, 'max_depth': 10, 'gamma': 6, 'learning_rate': 0.4296084743966924 and parameters: {'n estimators': 672, 'max_depth': 10, 'gamma': 6, 'learning_rate': 0.4296084743966924 and parameters: {'n estimators': 672, 'max_depth': 10, 'gamma': 6, 'learning_rate': 0.4296084743966924 and parameters: {'n estimators': 672, 'max_depth': 0.4296084743966924 and parameters: {'n estimators'
	ators': 614, 'max_depth': 10, 'gamma': 4, 'learning_rate': 0.020649205192140446}. Best is trial 7 wit h value: 0.5015289450059657.  [I 2022-03-29 17:05:02,385] Trial 13 finished with value: 0.7884983323189487 and parameters: {'n_estimators': 662, 'max_depth': 6, 'gamma': 0, 'learning_rate': 0.00536629415301921}. Best is trial 13 wit h value: 0.7884983323189487.  [I 2022-03-29 17:05:07,249] Trial 14 finished with value: 0.775562170115496 and parameters: {'n_estimators': 562, 'max_depth': 6, 'gamma': 0, 'learning_rate': 0.005437679646486608}. Best is trial 13 wit h value: 0.7884983323189487.  [I 2022-03-29 17:05:28,974] Trial 15 finished with value: 0.5807034790627006 and parameters: {'n_estimators': 646, 'max_depth': 7, 'gamma': 2, 'learning_rate': 0.0050692554812034225}. Best is trial 13 with value: 0.7884983323189487.
	[I 2022-03-29 17:05:32,664] Trial 12 finished with value: 0.05984513224835726 and parameters: {'n_est imators': 691, 'max_depth': 9, 'gamma': 12, 'learning_rate': 0.00614556310255914}. Best is trial 13 w ith value: 0.7884983323189487. [I 2022-03-29 17:05:51,833] Trial 16 finished with value: 0.7877235894658845 and parameters: {'n_esti mators': 704, 'max_depth': 6, 'gamma': 0, 'learning_rate': 0.005099353387508482}. Best is trial 13 wi th value: 0.7884983323189487. [I 2022-03-29 17:06:03,939] Trial 17 finished with value: 0.7888203656041444 and parameters: {'n_esti mators': 699, 'max_depth': 7, 'gamma': 0, 'learning_rate': 0.005566786965704607}. Best is trial 17 wi th value: 0.7888203656041444. [I 2022-03-29 17:06:21,090] Trial 19 finished with value: 0.7977273039148688 and parameters: {'n_esti mators': 750, 'max_depth': 6, 'gamma': 0, 'learning_rate': 0.006649819205397898}. Best is trial 19 wi
	th value: 0.7977273039148688.  [I 2022-03-29 17:06:26,785] Trial 18 finished with value: 0.7888813283250762 and parameters: {'n_estimators': 746, 'max_depth': 7, 'gamma': 0, 'learning_rate': 0.005169823578286697}. Best is trial 19 with value: 0.7977273039148688.  [I 2022-03-29 17:07:02,083] Trial 20 finished with value: 0.7945259809122496 and parameters: {'n_estimators': 771, 'max_depth': 8, 'gamma': 0, 'learning_rate': 0.007719308867807033}. Best is trial 19 with value: 0.7977273039148688.  [I 2022-03-29 17:07:06,363] Trial 21 finished with value: 0.5838970282239289 and parameters: {'n_estimators': 738, 'max_depth': 7, 'gamma': 2, 'learning_rate': 0.007409659873620154}. Best is trial 19 with value: 0.7977273039148688.  [I 2022-03-29 17:08:00,891] Trial 22 finished with value: 0.5840310460852521 and parameters: {'n_estimators': 878, 'max_depth': 8, 'gamma': 2, 'learning_rate': 0.00805093324095132}. Best is trial 19 with value: 0.5878, 'max_depth': 8, 'gamma': 2, 'learning_rate': 0.00805093324095132}. Best is trial 19 with value: 0.5878, 'max_depth': 8, 'gamma': 2, 'learning_rate': 0.00805093324095132}. Best is trial 19 with value: 0.5878, 'max_depth': 8, 'gamma': 2, 'learning_rate': 0.00805093324095132}. Best is trial 19 with value: 0.5878, 'max_depth': 8, 'gamma': 2, 'learning_rate': 0.00805093324095132}. Best is trial 19 with value: 0.5878, 'max_depth': 8, 'gamma': 2, 'learning_rate': 0.00805093324095132}. Best is trial 19 with value: 0.5878, 'max_depth': 8, 'gamma': 2, 'learning_rate': 0.00805093324095132}. Best is trial 19 with value: 0.5878, 'max_depth': 8, 'gamma': 2, 'learning_rate': 0.00805093324095132}. Best is trial 19 with value: 0.5878, 'max_depth': 8, 'gamma': 2, 'learning_rate': 0.00805093324095132}.
	mators': 878, 'max_depth': 8, 'gamma': 2, 'learning_rate': 0.00805093324095132}. Best is trial 19 wit h value: 0.7977273039148688.  [I 2022-03-29 17:08:10,449] Trial 23 finished with value: 0.5847052048420345 and parameters: {'n_esti mators': 888, 'max_depth': 8, 'gamma': 2, 'learning_rate': 0.007828300821806971}. Best is trial 19 wi th value: 0.7977273039148688.  [I 2022-03-29 17:08:52,940] Trial 25 finished with value: 0.5844919562897698 and parameters: {'n_esti mators': 852, 'max_depth': 8, 'gamma': 2, 'learning_rate': 0.00799288007495267}. Best is trial 19 wit h value: 0.7977273039148688.  [I 2022-03-29 17:08:53,207] Trial 24 finished with value: 0.5842697996812098 and parameters: {'n_esti mators': 889, 'max_depth': 8, 'gamma': 2, 'learning_rate': 0.007817669805344247}. Best is trial 19 wi th value: 0.7977273039148688.  [I 2022-03-29 17:09:04,516] Trial 27 finished with value: 0.6802667205088011 and parameters: {'n_esti mators': 800, 'max_depth': 8, 'gamma': 2, 'learning_rate': 0.007817669805344247}.
	mators': 781, 'max_depth': 5, 'gamma': 1, 'learning_rate': 0.020421487534968922}. Best is trial 19 wi th value: 0.7977273039148688.  [I 2022-03-29 17:09:30,283] Trial 26 finished with value: 0.6773843748904211 and parameters: {'n_esti mators': 781, 'max_depth': 8, 'gamma': 1, 'learning_rate': 0.008418240206845826}. Best is trial 19 wi th value: 0.7977273039148688.  [I 2022-03-29 17:09:40,101] Trial 28 finished with value: 0.8192910100327856 and parameters: {'n_esti mators': 770, 'max_depth': 5, 'gamma': 0, 'learning_rate': 0.024879135909735388}. Best is trial 28 wi th value: 0.8192910100327856.  [I 2022-03-29 17:09:41,243] Trial 29 finished with value: 0.678881924174507 and parameters: {'n_estim ators': 775, 'max_depth': 5, 'gamma': 1, 'learning_rate': 0.020607590732550012}. Best is trial 28 with value: 0.8192910100327856.
	[I 2022-03-29 17:09:49,304] Trial 30 finished with value: 0.6761061165456101 and parameters: {'n_estimators': 754, 'max_depth': 5, 'gamma': 1, 'learning_rate': 0.0066909119751283955}. Best is trial 28 with value: 0.8192910100327856.  [I 2022-03-29 17:10:01,464] Trial 33 finished with value: 0.436465242285332 and parameters: {'n_estimators': 602, 'max_depth': 3, 'gamma': 4, 'learning_rate': 0.031642692276006634}. Best is trial 28 with value: 0.8192910100327856.  [I 2022-03-29 17:10:11,819] Trial 32 finished with value: 0.4298396869563537 and parameters: {'n_estimators': 580, 'max_depth': 5, 'gamma': 4, 'learning_rate': 0.027877836935222926}. Best is trial 28 with value: 0.8192910100327856.  [I 2022-03-29 17:10:12,219] Trial 31 finished with value: 0.4246679107577357 and parameters: {'n_estimators': 748, 'max_depth': 5, 'gamma': 4, 'learning_rate': 0.006518942493832721}. Best is trial 28 with value: 0.8192910100327856.
	th value: 0.8192910100327856. [I 2022-03-29 17:10:26,051] Trial 34 finished with value: 0.8071855872513389 and parameters: {'n_esti mators': 592, 'max_depth': 6, 'gamma': 0, 'learning_rate': 0.03157655676790039}. Best is trial 28 wit h value: 0.8192910100327856. [I 2022-03-29 17:10:50,284] Trial 38 finished with value: 0.8086496878393922 and parameters: {'n_esti mators': 403, 'max_depth': 6, 'gamma': 0, 'learning_rate': 0.05446729579739477}. Best is trial 28 wit h value: 0.8192910100327856. [I 2022-03-29 17:10:52,477] Trial 35 finished with value: 0.8039157818906153 and parameters: {'n_esti mators': 843, 'max_depth': 6, 'gamma': 0, 'learning_rate': 0.02515282148666253}. Best is trial 28 wit h value: 0.8192910100327856. [I 2022-03-29 17:11:01,415] Trial 37 finished with value: 0.8050399819123728 and parameters: {'n_esti mators': 815, 'max_depth': 6, 'gamma': 0, 'learning_rate': 0.017055526185003906}. Best is trial 28 wi
	mators': 815, 'max_depth': 6, 'gamma': 0, 'learning_rate': 0.017055526185003906}. Best is trial 28 wi th value: 0.8192910100327856.  [I 2022-03-29 17:11:02,738] Trial 36 finished with value: 0.804424761137463 and parameters: {'n_estim ators': 841, 'max_depth': 6, 'gamma': 0, 'learning_rate': 0.016619720049439134}. Best is trial 28 wit h value: 0.8192910100327856.  [I 2022-03-29 17:11:07,086] Trial 40 finished with value: 0.5140603204921159 and parameters: {'n_estimators': 444, 'max_depth': 3, 'gamma': 3, 'learning_rate': 0.058761781128935056}. Best is trial 28 with value: 0.8192910100327856.  [I 2022-03-29 17:11:16,092] Trial 39 finished with value: 0.5207181346226987 and parameters: {'n_estimators': 389, 'max_depth': 6, 'gamma': 3, 'learning_rate': 0.07313576284164515}. Best is trial 28 with value: 0.8192910100327856.  [I 2022-03-29 17:11:16,172] Trial 41 finished with value: 0.6644484753582386 and parameters: {'n_estimators': 2022-03-29 17:11:16,172] Trial 41 finished with value: 0.6644484753582386 and parameters: {'n_estimators': 389, 'max_depth': 6, 'gamma': 3, 'learning_rate': 0.0644484753582386 and parameters: {'n_estimators': 2022-03-29 17:11:16,172] Trial 41 finished with value: 0.6644484753582386 and parameters: {'n_estimators': 2022-03-29 17:11:16,172] Trial 41 finished with value: 0.6644484753582386 and parameters: {'n_estimators': 2022-03-29 17:11:16,172] Trial 41 finished with value: 0.6644484753582386 and parameters: {'n_estimators': 2022-03-29 17:11:16,172] Trial 41 finished with value: 0.6644484753582386 and parameters: {'n_estimators': 2022-03-29 17:11:16,172] Trial 41 finished with value: 0.6644484753582386 and parameters: {'n_estimators': 2022-03-29 17:11:16,172] Trial 41 finished with value: 20.6644484753582386 and 2022-203-29 17:11:16,172] Trial 41 finished with value: 20.6644484753582386 and 2022-203-29 17:11:16,172]
	mators': 456, 'max_depth': 3, 'gamma': 1, 'learning_rate': 0.05168171231594435}. Best is trial 28 wit h value: 0.8192910100327856.  [I 2022-03-29 17:11:18,706] Trial 42 finished with value: 0.5099121276387134 and parameters: {'n_esti mators': 371, 'max_depth': 4, 'gamma': 3, 'learning_rate': 0.06006295217733131}. Best is trial 28 wit h value: 0.8192910100327856.  [I 2022-03-29 17:11:25,396] Trial 43 finished with value: 0.38397105343490556 and parameters: {'n_esti mators': 426, 'max_depth': 4, 'gamma': 5, 'learning_rate': 0.07962191964574042}. Best is trial 28 with value: 0.8192910100327856.  [I 2022-03-29 17:11:38,094] Trial 44 finished with value: 0.6785800642361949 and parameters: {'n_esti mators': 524, 'max_depth': 4, 'gamma': 1, 'learning_rate': 0.016181347369789607}. Best is trial 28 with value: 0.8192910100327856.
	[I 2022-03-29 17:11:38,609] Trial 45 finished with value: 0.676871239358112 and parameters: {'n_estim ators': 529, 'max_depth': 4, 'gamma': 1, 'learning_rate': 0.016840508065119098}. Best is trial 28 with value: 0.8192910100327856.  [I 2022-03-29 17:11:53,746] Trial 46 finished with value: 0.6777929186847307 and parameters: {'n_estim ators': 839, 'max_depth': 4, 'gamma': 1, 'learning_rate': 0.016756419817718117}. Best is trial 28 with value: 0.8192910100327856.  [I 2022-03-29 17:11:57,399] Trial 47 finished with value: 0.6796006143342903 and parameters: {'n_estimators': 505, 'max_depth': 6, 'gamma': 1, 'learning_rate': 0.017000479953334483}. Best is trial 28 with value: 0.8192910100327856.  [I 2022-03-29 17:12:13,905] Trial 50 finished with value: 0.7989812491055289 and parameters: {'n_estimators': 331, 'max_depth': 6, 'gamma': 0, 'learning_rate': 0.034726283308486657}. Best is trial 28 with value: 0.7989812491055289 and parameters: {'n_estimators': 331, 'max_depth': 6, 'gamma': 0, 'learning_rate': 0.034726283308486657}. Best is trial 28 with value: 0.7989812491055289 and parameters: {'n_estimators': 331, 'max_depth': 6, 'gamma': 0, 'learning_rate': 0.034726283308486657}. Best is trial 28 with value: 0.7989812491055289
	th value: 0.8192910100327856.  [I 2022-03-29 17:12:17,940] Trial 51 finished with value: 0.775926183396848 and parameters: {'n_estim ators': 283, 'max_depth': 7, 'gamma': 0, 'learning_rate': 0.01105985487677908}. Best is trial 28 with value: 0.8192910100327856.  [I 2022-03-29 17:12:33,188] Trial 49 finished with value: 0.12024572587791564 and parameters: {'n_estimators': 821, 'max_depth': 6, 'gamma': 10, 'learning_rate': 0.034384688987205786}. Best is trial 28 with value: 0.8192910100327856.  [I 2022-03-29 17:12:33,317] Trial 52 finished with value: 0.7949947218242344 and parameters: {'n_estimators': 274, 'max_depth': 7, 'gamma': 0, 'learning_rate': 0.046175109055662654}. Best is trial 28 with value: 0.8192910100327856.  [I 2022-03-29 17:12:42,464] Trial 48 finished with value: 0.12143263489042404 and parameters: {'n_estimators': 274, 'max_depth': 7, 'gamma': 0, 'learning_rate': 0.046175109055662654}.
	<pre>imators': 820, 'max_depth': 7, 'gamma': 10, 'learning_rate': 0.03479039447494271}. Best is trial 28 w ith value: 0.8192910100327856. [I 2022-03-29 17:13:14,209] Trial 54 finished with value: 0.8188408880957825 and parameters: {'n_esti mators': 809, 'max_depth': 5, 'gamma': 0, 'learning_rate': 0.024494900420292762}. Best is trial 28 wi th value: 0.8192910100327856. [I 2022-03-29 17:13:16,615] Trial 55 finished with value: 0.8192272527269242 and parameters: {'n_esti mators': 860, 'max_depth': 5, 'gamma': 0, 'learning_rate': 0.024519118995876606}. Best is trial 28 wi th value: 0.8192910100327856. [I 2022-03-29 17:13:25,606] Trial 56 finished with value: 0.820083761951518 and parameters: {'n_estim ators': 859, 'max_depth': 5, 'gamma': 0, 'learning_rate': 0.02454069258661942}. Best is trial 56 with value: 0.820083761951518.</pre>
	<pre>[I 2022-03-29 17:13:41,939] Trial 53 finished with value: 0.14906017204804445 and parameters: {'n_est imators': 806, 'max_depth': 9, 'gamma': 9, 'learning_rate': 0.024630527308042327}. Best is trial 56 w ith value: 0.820083761951518. [I 2022-03-29 17:13:45,955] Trial 57 finished with value: 0.8196912892924922 and parameters: {'n_esti mators': 637, 'max_depth': 5, 'gamma': 0, 'learning_rate': 0.023821020956309728}. Best is trial 56 wi th value: 0.820083761951518. [I 2022-03-29 17:13:48,519] Trial 58 finished with value: 0.8171769575994258 and parameters: {'n_esti mators': 626, 'max_depth': 5, 'gamma': 0, 'learning_rate': 0.024327650567502215}. Best is trial 56 wi th value: 0.820083761951518. [I 2022-03-29 17:14:18,274] Trial 59 finished with value: 0.5883168833741422 and parameters: {'n_esti mators': 865, 'max_depth': 5, 'gamma': 2, 'learning_rate': 0.02354686850043306}. Best is trial 56 with value: 0.820083761951518.</pre>
	[I 2022-03-29 17:14:26,246] Trial 61 finished with value: 0.5902281839669601 and parameters: {'n_estimators': 627, 'max_depth': 5, 'gamma': 2, 'learning_rate': 0.025218777685040744}. Best is trial 56 with value: 0.820083761951518.  [I 2022-03-29 17:14:26,819] Trial 60 finished with value: 0.5875833046529546 and parameters: {'n_estimators': 722, 'max_depth': 5, 'gamma': 2, 'learning_rate': 0.02341602418959739}. Best is trial 56 with value: 0.820083761951518.  [I 2022-03-29 17:14:30,406] Trial 62 finished with value: 0.5890913740599926 and parameters: {'n_estimators': 661, 'max_depth': 5, 'gamma': 2, 'learning_rate': 0.02372356453317411}. Best is trial 56 with value: 0.820083761951518.  [I 2022-03-29 17:14:36,481] Trial 65 finished with value: 0.6790379974681345 and parameters: {'n_estimators': 224, 'max_depth': 4, 'gamma': 1, 'learning_rate': 0.02851304960156782}. Best is trial 56 with value: 0.6790379974681345.
	h value: 0.820083761951518.  [I 2022-03-29 17:14:38,645] Trial 63 finished with value: 0.6604114776176168 and parameters: {'n_estimators': 621, 'max_depth': 3, 'gamma': 1, 'learning_rate': 0.026500008319375743}. Best is trial 56 with value: 0.820083761951518.  [I 2022-03-29 17:14:53,459] Trial 66 finished with value: 0.23049510931115785 and parameters: {'n_estimators': 694, 'max_depth': 3, 'gamma': 7, 'learning_rate': 0.01865842274116405}. Best is trial 56 with value: 0.820083761951518.  [I 2022-03-29 17:15:03,461] Trial 64 finished with value: 0.6792491855944801 and parameters: {'n_estimators': 714, 'max_depth': 5, 'gamma': 1, 'learning_rate': 0.02818742338079564}. Best is trial 56 with value: 0.820083761951518.  [I 2022-03-29 17:15:08,174] Trial 68 finished with value: 0.8181184306627969 and parameters: {'n_estimators': 715:08,174] Trial 68 finished with value: 0.8181184306627969 and parameters: {'n_estimators': 715:08,174] Trial 68 finished with value: 0.8181184306627969 and parameters: {'n_estimators': 715:08,174] Trial 68 finished with value: 0.8181184306627969 and parameters: {'n_estimators': 716:08,174] Trial 68 finished with value: 0.8181184306627969 and parameters: {'n_estimators': 716:08,174] Trial 68 finished with value: 0.8181184306627969 and parameters: {'n_estimators': 716:08,174] Trial 68 finished with value: 0.8181184306627969 and parameters: {'n_estimators': 716:08,174] Trial 68 finished with value: 0.8181184306627969 and parameters: {'n_estimators': 716:08,174] Trial 68 finished with value: 0.8181184306627969 and parameters: {'n_estimators': 716:08,174] Trial 68 finished with value: 0.8181184306627969 and parameters: {'n_estimators': 716:08,174] Trial 68 finished with value: 0.8181184306627969 and parameters: {'n_estimators': 716:08,174] Trial 68 finished with value: 0.8181184306627969 and parameters: {'n_estimators': 716:08,174] Trial 68 finished with value: 0.8181184306627969 and parameters: {'n_estimators': 716:08,174] Trial 68 finished with value: 0.8181184306627969 and parameters: {'n_est
	mators': 566, 'max_depth': 5, 'gamma': 0, 'learning_rate': 0.021445633729181634}. Best is trial 56 wi th value: 0.820083761951518.  [I 2022-03-29 17:15:12,344] Trial 67 finished with value: 0.8150849006040307 and parameters: {'n_esti mators': 689, 'max_depth': 5, 'gamma': 0, 'learning_rate': 0.018793895566237423}. Best is trial 56 wi th value: 0.820083761951518.  [I 2022-03-29 17:15:33,318] Trial 70 finished with value: 0.8172552037428986 and parameters: {'n_esti mators': 561, 'max_depth': 5, 'gamma': 0, 'learning_rate': 0.021695272888477245}. Best is trial 56 wi th value: 0.820083761951518.  [I 2022-03-29 17:15:36,212] Trial 72 finished with value: 0.8179600989069776 and parameters: {'n_esti mators': 568, 'max_depth': 4, 'gamma': 0, 'learning_rate': 0.021912469391505904}. Best is trial 56 wi th value: 0.820083761951518.  [I 2022-03-29 17:15:40,360] Trial 69 finished with value: 0.8176567507862378 and parameters: {'n_esti mators': 568, 'max_depth': 4, 'gamma': 0, 'learning_rate': 0.021912469391505904}.
	mators': 898, 'max_depth': 5, 'gamma': 0, 'learning_rate': 0.022406454888634783}. Best is trial 56 wi th value: 0.820083761951518.  [I 2022-03-29 17:15:41,843] Trial 71 finished with value: 0.8223011465147609 and parameters: {'n_esti mators': 794, 'max_depth': 4, 'gamma': 0, 'learning_rate': 0.021610653915569284}. Best is trial 71 wi th value: 0.8223011465147609.  [I 2022-03-29 17:16:00,099] Trial 74 finished with value: 0.8231901462606253 and parameters: {'n_esti mators': 540, 'max_depth': 4, 'gamma': 0, 'learning_rate': 0.021394483919072643}. Best is trial 74 wi th value: 0.8231901462606253.  [I 2022-03-29 17:16:15,520] Trial 73 finished with value: 0.06365143059927443 and parameters: {'n_esti mators': 871, 'max_depth': 4, 'gamma': 12, 'learning_rate': 0.021890945037638096}. Best is trial 74 with value: 0.8231901462606253.
	<pre>[I 2022-03-29 17:16:18,974] Trial 75 finished with value: 0.822285029518189 and parameters: {'n_estim ators': 794, 'max_depth': 4, 'gamma': 0, 'learning_rate': 0.022148506387945216}. Best is trial 74 with value: 0.8231901462606253. [I 2022-03-29 17:16:23,829] Trial 77 finished with value: 0.5602509892207381 and parameters: {'n_estim ators': 798, 'max_depth': 2, 'gamma': 1, 'learning_rate': 0.019363279054535294}. Best is trial 74 with value: 0.8231901462606253. [I 2022-03-29 17:16:23,946] Trial 76 finished with value: 0.8203895044589988 and parameters: {'n_estimators': 867, 'max_depth': 4, 'gamma': 0, 'learning_rate': 0.019032004782168557}. Best is trial 74 with value: 0.8231901462606253. [I 2022-03-29 17:16:38,070] Trial 78 finished with value: 0.5595230225551432 and parameters: {'n_estimators': 796, 'max_depth': 2, 'gamma': 1, 'learning_rate': 0.019001793027227053}. Best is trial 74 with value: 796, 'max_depth': 2, 'gamma': 1, 'learning_rate': 0.019001793027227053}.</pre>
	th value: 0.8231901462606253. [I 2022-03-29 17:16:41,632] Trial 79 finished with value: 0.5625752442204586 and parameters: {'n_esti mators': 795, 'max_depth': 2, 'gamma': 1, 'learning_rate': 0.019308689448761483}. Best is trial 74 wi th value: 0.8231901462606253. [I 2022-03-29 17:16:45,700] Trial 81 finished with value: 0.5603135299444428 and parameters: {'n_esti mators': 788, 'max_depth': 2, 'gamma': 1, 'learning_rate': 0.014841476058774263}. Best is trial 74 wi th value: 0.8231901462606253. [I 2022-03-29 17:17:00,395] Trial 80 finished with value: 0.6779381415687173 and parameters: {'n_esti mators': 791, 'max_depth': 4, 'gamma': 1, 'learning_rate': 0.015000791655698899}. Best is trial 74 wi th value: 0.8231901462606253. [I 2022-03-29 17:17:16,289] Trial 82 finished with value: 0.67708556024222 and parameters: {'n_estima tors': 897, 'max_depth': 4, 'gamma': 1, 'learning_rate': 0.014858521057970676}. Best is trial 74 with
	<pre>value: 0.8231901462606253. [I 2022-03-29 17:17:17,333] Trial 84 finished with value: 0.8189661778921309 and parameters: {'n_esti mators': 764, 'max_depth': 4, 'gamma': 0, 'learning_rate': 0.030562924030874718}. Best is trial 74 wi th value: 0.8231901462606253. [I 2022-03-29 17:17:17,540] Trial 83 finished with value: 0.8189440982799232 and parameters: {'n_esti mators': 861, 'max_depth': 4, 'gamma': 0, 'learning_rate': 0.030828032711098338}. Best is trial 74 wi th value: 0.8231901462606253. [I 2022-03-29 17:17:37,688] Trial 85 finished with value: 0.818164629722997 and parameters: {'n_estim ators': 899, 'max_depth': 4, 'gamma': 0, 'learning_rate': 0.03042932883142615}. Best is trial 74 with value: 0.8231901462606253. [I 2022-03-29 17:17:41,655] Trial 87 finished with value: 0.8109429142939965 and parameters: {'n_estimestimestimestimestimestimestimestim</pre>
	mators': 763, 'max_depth': 3, 'gamma': 0, 'learning_rate': 0.029667738730686302}. Best is trial 74 wi th value: 0.8231901462606253.  [I 2022-03-29 17:17:43,499] Trial 86 finished with value: 0.8151839303413713 and parameters: {'n_esti mators': 854, 'max_depth': 3, 'gamma': 0, 'learning_rate': 0.030825178290352917}. Best is trial 74 wi th value: 0.8231901462606253.  [I 2022-03-29 17:17:44,144] Trial 88 finished with value: 0.8118230059358744 and parameters: {'n_esti mators': 836, 'max_depth': 3, 'gamma': 0, 'learning_rate': 0.02667895309839276}. Best is trial 74 wit h value: 0.8231901462606253.  [I 2022-03-29 17:18:01,867] Trial 89 finished with value: 0.8157448121931907 and parameters: {'n_esti mators': 764, 'max_depth': 3, 'gamma': 0, 'learning_rate': 0.02593335750340127}. Best is trial 74 wit h value: 0.8231901462606253.
	<pre>[I 2022-03-29 17:18:04,774] Trial 90 finished with value: 0.8128668522779288 and parameters: {'n_esti mators': 726, 'max_depth': 3, 'gamma': 0, 'learning_rate': 0.026723474990669713}. Best is trial 74 wi th value: 0.8231901462606253. [I 2022-03-29 17:18:09,588] Trial 91 finished with value: 0.8118307680607029 and parameters: {'n_esti mators': 826, 'max_depth': 3, 'gamma': 0, 'learning_rate': 0.02699330951709988}. Best is trial 74 wit h value: 0.8231901462606253. [I 2022-03-29 17:18:14,290] Trial 92 finished with value: 0.8218617497438345 and parameters: {'n_esti mators': 738, 'max_depth': 4, 'gamma': 0, 'learning_rate': 0.036756011105948005}. Best is trial 74 wit th value: 0.8231901462606253. [I 2022-03-29 17:18:35,594] Trial 93 finished with value: 0.8197463073109127 and parameters: {'n_esti mators': 828, 'max_depth': 4, 'gamma': 0, 'learning_rate': 0.02033460902878889}. Best is trial 74 wit h value: 0.8231901462606253.</pre>
	[I 2022-03-29 17:18:40,460] Trial 94 finished with value: 0.8233988044504381 and parameters: {'n_estimators': 875, 'max_depth': 4, 'gamma': 0, 'learning_rate': 0.03708326953769646}. Best is trial 94 with value: 0.8233988044504381.  [I 2022-03-29 17:18:44,608] Trial 96 finished with value: 0.6825706174652073 and parameters: {'n_estimators': 747, 'max_depth': 4, 'gamma': 1, 'learning_rate': 0.04265083979753713}. Best is trial 94 with value: 0.8233988044504381.  [I 2022-03-29 17:18:45,040] Trial 95 finished with value: 0.8224693944328016 and parameters: {'n_estimators': 877, 'max_depth': 4, 'gamma': 0, 'learning_rate': 0.03657679334399234}. Best is trial 94 with value: 0.8233988044504381.  [I 2022-03-29 17:19:11,681] Trial 97 finished with value: 0.6795810289206371 and parameters: {'n_estimators': 879, 'max_depth': 4, 'gamma': 1, 'learning_rate': 0.020879009391169868}. Best is trial 94 with value: 0.8234693944328016 and parameters: {'n_estimators': 879, 'max_depth': 4, 'gamma': 1, 'learning_rate': 0.020879009391169868}. Best is trial 94 with value: 0.823988044504381.
	th value: 0.8233988044504381.  [I 2022-03-29 17:19:16,871] Trial 98 finished with value: 0.6783018353070832 and parameters: {'n_estimators': 881, 'max_depth': 4, 'gamma': 1, 'learning_rate': 0.04166123422485909}. Best is trial 94 with value: 0.8233988044504381.  [I 2022-03-29 17:19:20,916] Trial 99 finished with value: 0.678677301856405 and parameters: {'n_estimators': 881, 'max_depth': 4, 'gamma': 1, 'learning_rate': 0.03952271466194257}. Best is trial 94 with value: 0.8233988044504381.  [I 2022-03-29 17:19:20,986] Trial 100 finished with value: 0.677621486910463 and parameters: {'n_estimators': 879, 'max_depth': 4, 'gamma': 1, 'learning_rate': 0.038502247356960846}. Best is trial 94 with value: 0.8233988044504381.  [I 2022-03-29 17:19:47,726] Trial 101 finished with value: 0.6789732072400838 and parameters: {'n_estimators': 879, 'max_depth': 4, 'gamma': 1, 'learning_rate': 0.038502247356960846}.
	<pre>imators': 880, 'max_depth': 4, 'gamma': 1, 'learning_rate': 0.03906462318403987}. Best is trial 94 wi th value: 0.8233988044504381. [I 2022-03-29 17:19:51,513] Trial 102 finished with value: 0.8267417229965478 and parameters: {'n_est imators': 846, 'max_depth': 4, 'gamma': 0, 'learning_rate': 0.038362431395918314}. Best is trial 102 with value: 0.8267417229965478. [I 2022-03-29 17:19:54,218] Trial 103 finished with value: 0.81950149034558 and parameters: {'n_estim ators': 828, 'max_depth': 4, 'gamma': 0, 'learning_rate': 0.036110987902343454}. Best is trial 102 wi th value: 0.8267417229965478. [I 2022-03-29 17:19:54,356] Trial 104 finished with value: 0.825002064444375 and parameters: {'n_estim ators': 829, 'max_depth': 4, 'gamma': 0, 'learning_rate': 0.03242905878697262}. Best is trial 102 wi th value: 0.8267417229965478.</pre>
	[I 2022-03-29 17:20:21,063] Trial 108 finished with value: 0.8170789623781239 and parameters: {'n_est imators': 843, 'max_depth': 3, 'gamma': 0, 'learning_rate': 0.04629200880123085}. Best is trial 102 w ith value: 0.8267417229965478.  [I 2022-03-29 17:20:21,160] Trial 107 finished with value: 0.8134818060390316 and parameters: {'n_est imators': 850, 'max_depth': 3, 'gamma': 0, 'learning_rate': 0.03359946282369625}. Best is trial 102 w ith value: 0.8267417229965478.  [I 2022-03-29 17:20:25,769] Trial 106 finished with value: 0.8222305764113621 and parameters: {'n_est imators': 830, 'max_depth': 4, 'gamma': 0, 'learning_rate': 0.03646231560408705}. Best is trial 102 w ith value: 0.8267417229965478.  [I 2022-03-29 17:20:29,812] Trial 105 finished with value: 0.8175691605014815 and parameters: {'n_est imators': 829, 'max_depth': 5, 'gamma': 0, 'learning_rate': 0.03590694495866818}. Best is trial 102 w ith value: 0.8267417229965478.
	[I 2022-03-29 17:20:46,234] Trial 111 finished with value: 0.8229784653167878 and parameters: {'n_est imators': 484, 'max_depth': 4, 'gamma': 0, 'learning_rate': 0.04568855114648289}. Best is trial 102 w ith value: 0.8267417229965478.  [I 2022-03-29 17:20:49,951] Trial 112 finished with value: 0.8174523567354106 and parameters: {'n_est imators': 484, 'max_depth': 4, 'gamma': 0, 'learning_rate': 0.03298063271023324}. Best is trial 102 w ith value: 0.8267417229965478.  [I 2022-03-29 17:20:54,822] Trial 110 finished with value: 0.825251873856144 and parameters: {'n_esti mators': 810, 'max_depth': 4, 'gamma': 0, 'learning_rate': 0.036818233267093395}. Best is trial 102 w ith value: 0.8267417229965478.  [I 2022-03-29 17:20:55,034] Trial 109 finished with value: 0.8237423524601832 and parameters: {'n_est imators': 814, 'max_depth': 4, 'gamma': 0, 'learning_rate': 0.03313596671908557}. Best is trial 102 w ith value: 0.8267417229965478.
	[I 2022-03-29 17:21:06,796] Trial 113 finished with value: 0.6814633763901353 and parameters: {'n_est imators': 483, 'max_depth': 4, 'gamma': 1, 'learning_rate': 0.04673634059655587}. Best is trial 102 w ith value: 0.8267417229965478.  [I 2022-03-29 17:21:12,360] Trial 114 finished with value: 0.8191976130903363 and parameters: {'n_est imators': 542, 'max_depth': 4, 'gamma': 0, 'learning_rate': 0.04587629684931003}. Best is trial 102 w ith value: 0.8267417229965478.  [I 2022-03-29 17:21:16,505] Trial 116 finished with value: 0.6803104554252826 and parameters: {'n_est imators': 526, 'max_depth': 4, 'gamma': 1, 'learning_rate': 0.04574571439217801}. Best is trial 102 w ith value: 0.8267417229965478.  [I 2022-03-29 17:21:16,874] Trial 115 finished with value: 0.8272566129097854 and parameters: {'n_est imators': 538, 'max_depth': 4, 'gamma': 0, 'learning_rate': 0.04731322681890647}. Best is trial 115 w
	ith value: 0.8272566129097854.  [I 2022-03-29 17:21:33,755] Trial 120 finished with value: 0.8069013433780844 and parameters: {'n_est imators': 515, 'max_depth': 3, 'gamma': 0, 'learning_rate': 0.05585171749882355}. Best is trial 115 w ith value: 0.8272566129097854.  [I 2022-03-29 17:21:40,779] Trial 117 finished with value: 0.8258198502889675 and parameters: {'n_est imators': 808, 'max_depth': 4, 'gamma': 0, 'learning_rate': 0.050196490566602435}. Best is trial 115 with value: 0.8272566129097854.  [I 2022-03-29 17:21:42,937] Trial 119 finished with value: 0.8160486119572583 and parameters: {'n_est imators': 811, 'max_depth': 3, 'gamma': 0, 'learning_rate': 0.05098909085362072}. Best is trial 115 w ith value: 0.8272566129097854.  [I 2022-03-29 17:21:46,307] Trial 118 finished with value: 0.8241898704118988 and parameters: {'n_est imators': 811, 'max_depth': 3, 'gamma': 0, 'learning_rate': 0.05098909085362072}.
	<pre>imators': 809, 'max_depth': 4, 'gamma': 0, 'learning_rate': 0.043062975965504756}. Best is trial 115   with value: 0.8272566129097854. [I 2022-03-29 17:21:59,328] Trial 121 finished with value: 0.6650107327434853 and parameters: {'n_est imators': 809, 'max_depth': 3, 'gamma': 1, 'learning_rate': 0.04149861902103931}. Best is trial 115 w ith value: 0.8272566129097854. [I 2022-03-29 17:22:05,001] Trial 123 finished with value: 0.677043850669371 and parameters: {'n_esti mators': 540, 'max_depth': 4, 'gamma': 1, 'learning_rate': 0.06830464648051741}. Best is trial 115 wi th value: 0.8272566129097854. [I 2022-03-29 17:22:06,435] Trial 122 finished with value: 0.6683826527297462 and parameters: {'n_est imators': 809, 'max_depth': 3, 'gamma': 1, 'learning_rate': 0.051009441771284254}. Best is trial 115   with value: 0.8272566129097854. [I 2022-03-29 17:22:19,302] Trial 124 finished with value: 0.8241499592913939 and parameters: {'n est</pre>
	<pre>imators': 808, 'max_depth': 4, 'gamma': 0, 'learning_rate': 0.042659811270585206}. Best is trial 115 with value: 0.8272566129097854. [I 2022-03-29 17:22:30,904] Trial 127 finished with value: 0.8247142630373311 and parameters: {'n_est imators': 592, 'max_depth': 4, 'gamma': 0, 'learning_rate': 0.04313034708743467}. Best is trial 115 w ith value: 0.8272566129097854. [I 2022-03-29 17:22:31,179] Trial 125 finished with value: 0.8225735307204293 and parameters: {'n_est imators': 778, 'max_depth': 4, 'gamma': 0, 'learning_rate': 0.049755883750626}. Best is trial 115 wit h value: 0.8272566129097854. [I 2022-03-29 17:22:36,944] Trial 126 finished with value: 0.821598750094919 and parameters: {'n_esti mators': 783, 'max_depth': 4, 'gamma': 0, 'learning_rate': 0.049195995621411685}. Best is trial 115 w ith value: 0.8272566129097854.</pre>
	[I 2022-03-29 17:22:51,319] Trial 128 finished with value: 0.8231245569081207 and parameters: {'n_est imators': 780, 'max_depth': 4, 'gamma': 0, 'learning_rate': 0.04423488033314196}. Best is trial 115 w ith value: 0.8272566129097854.  [I 2022-03-29 17:22:55,324] Trial 130 finished with value: 0.826814815436385 and parameters: {'n_esti mators': 591, 'max_depth': 4, 'gamma': 0, 'learning_rate': 0.04348418192932856}. Best is trial 115 wi th value: 0.8272566129097854.  [I 2022-03-29 17:23:06,286] Trial 129 finished with value: 0.37573291362908706 and parameters: {'n_estimators': 777, 'max_depth': 4, 'gamma': 5, 'learning_rate': 0.04343080156043661}. Best is trial 115 with value: 0.8272566129097854.  [I 2022-03-29 17:23:09,588] Trial 131 finished with value: 0.8143054359665225 and parameters: {'n_estimators': 586, 'max_depth': 5, 'gamma': 0, 'learning_rate': 0.06340784128239055}. Best is trial 115 with value: 0.8272566129097854.
	<pre>[I 2022-03-29 17:23:18,940] Trial 132 finished with value: 0.37296870627838763 and parameters: {'n_es timators': 468, 'max_depth': 5, 'gamma': 5, 'learning_rate': 0.043679904523849136}. Best is trial 115 with value: 0.8272566129097854. [I 2022-03-29 17:23:28,818] Trial 133 finished with value: 0.5929970630618536 and parameters: {'n_est imators': 587, 'max_depth': 5, 'gamma': 2, 'learning_rate': 0.04329186406824542}. Best is trial 115 w ith value: 0.8272566129097854. [I 2022-03-29 17:23:33,954] Trial 135 finished with value: 0.8257730605856409 and parameters: {'n_est imators': 595, 'max_depth': 4, 'gamma': 0, 'learning_rate': 0.04370934979335481}. Best is trial 115 w ith value: 0.8272566129097854. [I 2022-03-29 17:23:36,883] Trial 134 finished with value: 0.8242568897746058 and parameters: {'n_est imators': 599, 'max_depth': 5, 'gamma': 0, 'learning_rate': 0.043754206894757945}. Best is trial 115</pre>
	with value: 0.8272566129097854. [I 2022-03-29 17:23:44,347] Trial 136 finished with value: 0.8265672252936735 and parameters: {'n_est imators': 609, 'max_depth': 4, 'gamma': 0, 'learning_rate': 0.04016815042836355}. Best is trial 115 w ith value: 0.8272566129097854. [I 2022-03-29 17:23:54,062] Trial 137 finished with value: 0.8261772613711974 and parameters: {'n_est imators': 613, 'max_depth': 4, 'gamma': 0, 'learning_rate': 0.04009758902251296}. Best is trial 115 w ith value: 0.8272566129097854. [I 2022-03-29 17:23:58,997] Trial 138 finished with value: 0.8180721655735075 and parameters: {'n_est imators': 608, 'max_depth': 4, 'gamma': 0, 'learning_rate': 0.054478697366927675}. Best is trial 115 with value: 0.8272566129097854. [I 2022-03-29 17:24:05,228] Trial 139 finished with value: 0.8122836722817881 and parameters: {'n_est imators': 554, 'max_depth': 5, 'gamma': 0, 'learning_rate': 0.05531507651996652}. Best is trial 115 w
	ith value: 0.8272566129097854.  [I 2022-03-29 17:24:15,319] Trial 140 finished with value: 0.8140465546340986 and parameters: {'n_est imators': 608, 'max_depth': 5, 'gamma': 0, 'learning_rate': 0.03999120681134522}. Best is trial 115 w ith value: 0.8272566129097854.  [I 2022-03-29 17:24:25,167] Trial 141 finished with value: 0.6829622457812204 and parameters: {'n_est imators': 607, 'max_depth': 5, 'gamma': 1, 'learning_rate': 0.039901518786214306}. Best is trial 115 with value: 0.8272566129097854.  [I 2022-03-29 17:24:29,881] Trial 142 finished with value: 0.6810040492781934 and parameters: {'n_est imators': 601, 'max_depth': 5, 'gamma': 1, 'learning_rate': 0.041098189848597436}. Best is trial 115 with value: 0.8272566129097854.  [I 2022-03-29 17:24:39,611] Trial 143 finished with value: 0.09455643648245993 and parameters: {'n_est imators': 601, 'max_depth': 5, 'gamma': 1, 'learning_rate': 0.041098189848597436}. Best is trial 115 with value: 0.8272566129097854.
	timators': 643, 'max_depth': 5, 'gamma': 11, 'learning_rate': 0.03988864656903248}. Best is trial 115 with value: 0.8272566129097854.  [I 2022-03-29 17:24:42,798] Trial 144 finished with value: 0.2930839356437088 and parameters: {'n_est imators': 652, 'max_depth': 4, 'gamma': 6, 'learning_rate': 0.03874103446859759}. Best is trial 115 w ith value: 0.8272566129097854.  [I 2022-03-29 17:24:50,823] Trial 145 finished with value: 0.8273982528321312 and parameters: {'n_est imators': 635, 'max_depth': 4, 'gamma': 0, 'learning_rate': 0.038376495123603714}. Best is trial 145 with value: 0.8273982528321312.  [I 2022-03-29 17:24:56,009] Trial 146 finished with value: 0.8212000862498376 and parameters: {'n_est imators': 638, 'max_depth': 4, 'gamma': 0, 'learning_rate': 0.048019222347104575}. Best is trial 145 with value: 0.8273982528321312.
In [52]:	<pre>[I 2022-03-29 17:25:03,306] Trial 147 finished with value: 0.8188277907122392 and parameters: {'n_est imators': 571, 'max_depth': 4, 'gamma': 0, 'learning_rate': 0.04880150132109453}. Best is trial 145 w ith value: 0.8273982528321312. [I 2022-03-29 17:25:06,342] Trial 148 finished with value: 0.8209259209369447 and parameters: {'n_est imators': 568, 'max_depth': 4, 'gamma': 0, 'learning_rate': 0.0486451712551846}. Best is trial 145 wi th value: 0.8273982528321312. [I 2022-03-29 17:25:13,294] Trial 149 finished with value: 0.8214943512052384 and parameters: {'n_est imators': 577, 'max_depth': 4, 'gamma': 0, 'learning_rate': 0.048777222220240064}. Best is trial 145 with value: 0.8273982528321312.</pre> <pre>best_params=study.best_trial.params</pre>
	<pre>def median_mape(y_true, y_pred):     y_true, y_pred = np.array(y_true).squeeze(), np.array(y_pred).squeeze()     y_m = [y_true != 0]     return np.median(np.abs((y_true[y_m] - y_pred[y_m]) / y_true[y_m])) * 100</pre> f_i = [] r2 = [] mae = [] mape = [] kf = KFold(n_splits=10)
In [21]:	При помощи кросс валидации выборка разбивается на 10 частей в соотношении 90%X10%, для каждой части модель предсказывает значение и записывает ошибку. В конце выводятся средние значения ошибок.  for train_index, test_index in kf.split(X_):     train_x, train_y = Xiloc[train_index], Yiloc[train_index]     test_x, test_y = Xiloc[test_index], Yiloc[test_index]  scaler_X = MinMaxScaler()     train_x_transformed = scaler_X.fit_transform(train_x)     test_x transformed = scaler_X.transform(test_x)
	<pre>scaler_Y = np.mean(np.mean(train_y)) #MinMaxScaler() train_y_transformed = train_y/scaler_Y##scaler_Y.fit_transform(np.array(train_Y).reshape(-1,1)) test_y_transformed = test_y/scaler_Y##scaler_Y.transform(np.array(test_Y))  model = XGBRegressor(**best_params) model.fit(X_transformed, Y_transformed)</pre>
	<pre>y_pred = model.predict(test_x_transformed)  y_pred[y_pred &lt; 0] = 0 y_pred = y_pred * scaler_Y  f_i.append(model.feature_importances_)  r2.append(r2_score(test_y, y_pred)) mae.append(mean_absolute_error(test_y, y_pred)) mape.append(median_mape(test_y, y_pred))  f_i = np.array(f_i).mean(axis=0)</pre>
	print('R2 = ', np.mean(r2)) print('MAE = ', np.mean(mae)) print('MAPE = ', np.mean(mape))  R2 = 0.8892761581886874 MAE = 8580.508057707246 MAPE = 3.583380869599688  Важность параметров:
In [22]:	<pre>Baжнocть параметров:  f_list=X.columns indices = np.argsort(f_i)[::-1] num_to_plot = 15 feature_indices = indices[:num_to_plot]  plt.figure(figsize=(15,5)) bars = plt.bar(range(num_to_plot),</pre>
	<pre>for i in range(num_to_plot)]),</pre>
	0.14
	0.00 Overall during the state of the state
In [ ]:	OverallQual - оценка общего материала и отделки дома MasVnrArea - толщина внешнего слоя кирпича стен дома PoolQC - Качество бассейна Electrical - Тип системы электричества TotalBsmtSF - Площадь подвала BsmtQual - Высота подвала