Mini-projeto-MLP

September 5, 2023

1 Mini Projeto MLP

###Grupo

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###Objetivo Verificar como a alteração de parâmtros (número de camadas, número de unidades, taxa de aprendizagem, funções de ativação, dropout, regularização, etc) interfere no resultado do experimento (os testes serão realizados com o Conjunto de Dados de Sintomas de Lombalgia disponível no Kaggle), utilizando sklearn.neural_network.MLPClassifier. Importante avaliar os dados, ver normalização e eliminar atributos identificadores. Medir acurácia, matriz de confusão, precision, recall.

##Importações e Downloads

[1]:
```
!pip install scikit-optimize
```

```
Collecting scikit-optimize
  Downloading scikit_optimize-0.9.0-py2.py3-none-any.whl (100 kB)
                           100.3/100.3
kB 2.3 MB/s eta 0:00:00
Requirement already satisfied: joblib>=0.11 in
/usr/local/lib/python3.10/dist-packages (from scikit-optimize) (1.3.2)
Collecting pyaml>=16.9 (from scikit-optimize)
  Downloading pyaml-23.9.1-py3-none-any.whl (18 kB)
Requirement already satisfied: numpy>=1.13.3 in /usr/local/lib/python3.10/dist-
packages (from scikit-optimize) (1.23.5)
Requirement already satisfied: scipy>=0.19.1 in /usr/local/lib/python3.10/dist-
packages (from scikit-optimize) (1.10.1)
Requirement already satisfied: scikit-learn>=0.20.0 in
/usr/local/lib/python3.10/dist-packages (from scikit-optimize) (1.2.2)
Requirement already satisfied: PyYAML in /usr/local/lib/python3.10/dist-packages
(from pyaml>=16.9->scikit-optimize) (6.0.1)
Requirement already satisfied: threadpoolctl>=2.0.0 in
/usr/local/lib/python3.10/dist-packages (from scikit-learn>=0.20.0->scikit-
optimize) (3.2.0)
Installing collected packages: pyaml, scikit-optimize
```

```
Successfully installed pyaml-23.9.1 scikit-optimize-0.9.0
```

[2]:
```
import pandas as pd
import numpy as np
from sklearn.preprocessing import LabelEncoder, StandardScaler, MinMaxScaler
from sklearn.model_selection import train_test_split, ShuffleSplit
from sklearn.neural_network import MLPClassifier
from sklearn.metrics import accuracy_score, classification_report,␣
 ↪confusion_matrix
import matplotlib.pyplot as plt
import seaborn as sns
from skopt.optimizer import gbrt_minimize
from skopt.space.space import Categorical, Integer, Real
from skopt.utils import use_named_args
from imblearn.over_sampling import SMOTE
```

##Preparando os dados

[3]:
```
from google.colab import drive
drive.mount('/content/drive')
```

```
Mounted at /content/drive
```

[4]:
```
df = pd.read_csv("/content/drive/MyDrive/Colab Notebooks/backpain/Dataset_spine.
 ↪csv")
df.drop([df.columns[-1]],axis=1,inplace=True)
df.head()
```

[4]:

	Col1	Col2	Col3	Col4	Col5	Col6	\
0	63.027817	22.552586	39.609117	40.475232	98.672917	-0.254400	
1	39.056951	10.060991	25.015378	28.995960	114.405425	4.564259	
2	68.832021	22.218482	50.092194	46.613539	105.985135	-3.530317	
3	69.297008	24.652878	44.311238	44.644130	101.868495	11.211523	
4	49.712859	9.652075	28.317406	40.060784	108.168725	7.918501	

	Col7	Col8	Col9	Col10	Col11	Col12	Class_att
0	0.744503	12.5661	14.5386	15.30468	-28.658501	43.5123	Abnormal
1	0.415186	12.8874	17.5323	16.78486	-25.530607	16.1102	Abnormal
2	0.474889	26.8343	17.4861	16.65897	-29.031888	19.2221	Abnormal
3	0.369345	23.5603	12.7074	11.42447	-30.470246	18.8329	Abnormal
4	0.543360	35.4940	15.9546	8.87237	-16.378376	24.9171	Abnormal

Pelo dicionário de dados, sabemos que: * Col1 - pelvic_incidence * Col2 - pelvic tilt * Col3 - lumbar_lordosis_angle * Col4 - sacral_slope * Col5 - pelvic_radius * Col6 - degree_spondylolisthesis * Col7 - pelvic_slope * Col8 - direct_tilt * Col9 - thoracic_slope * Col10 - cervical_tilt * Col11 - sacrum_angle * Col12 - scoliosis_slope * Class_att - Abnormal, Normal (Normality)

Por meio dos doze primeiros atributos, iremos prever o último.

[5]:
```
#Renomeando colunas
new_columns = ['pelvic_incidence','pelvic_tilt','lumbar_lordosis_angle',
        'sacral_slope','pelvic_radius','degree_spondylolisthesis',
        'pelvic_slope','direct_tilt','thoracic_slope','cervical_tilt',
        'sacrum_angle','scoliosis_slope','normality']

df.columns = new_columns
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 310 entries, 0 to 309
Data columns (total 13 columns):
 #   Column                    Non-Null Count  Dtype
---  ------                    --------------  -----
 0   pelvic_incidence          310 non-null    float64
 1   pelvic_tilt               310 non-null    float64
 2   lumbar_lordosis_angle     310 non-null    float64
 3   sacral_slope              310 non-null    float64
 4   pelvic_radius             310 non-null    float64
 5   degree_spondylolisthesis  310 non-null    float64
 6   pelvic_slope              310 non-null    float64
 7   direct_tilt               310 non-null    float64
 8   thoracic_slope            310 non-null    float64
 9   cervical_tilt             310 non-null    float64
 10  sacrum_angle              310 non-null    float64
 11  scoliosis_slope           310 non-null    float64
 12  normality                 310 non-null    object
dtypes: float64(12), object(1)
memory usage: 31.6+ KB
```

Os dados estão completos, sem campos NaN. Os atributos são todos do tipo númerico, no entanto o target é do tipo object.

[6]:
```
df["normality"].value_counts()
```

[6]:
```
Abnormal    210
Normal      100
Name: normality, dtype: int64
```

[7]:
```
#Transformar o último campo com encoder para 0 (Abnormal) e 1 (Normal)
label_encoder = LabelEncoder()
df["normality"] = label_encoder.fit_transform(df["normality"])
df["normality"].value_counts()
```

[7]:
```
0    210
1    100
Name: normality, dtype: int64
```

[8]:
```
#Separar atributos e label
x = df.iloc[:, :-1]
y = df["normality"]
```

##Análise Exploratória dos Dados e Pré-Processamento

###Verificar eficácia sem pré-processamento

[9]:
```
def estimar_loss(x, y):
  x_train, x_test, y_train, y_test = train_test_split(x, y, test_size=0.
 ↪15,random_state=42, shuffle=True)
  #Modelo com valores usuais
  mlp_classifier = MLPClassifier(hidden_layer_sizes=(100,), activation='relu',␣
 ↪solver='adam', alpha=0.0001,
                                 batch_size='auto', learning_rate='constant',␣
 ↪learning_rate_init=0.001, power_t=0.5,
                                 max_iter=200, shuffle=True, random_state=42,␣
 ↪tol=0.0001, verbose=False,
                                 warm_start=False, momentum=0.9,␣
 ↪nesterovs_momentum=True, early_stopping=False,
                                 validation_fraction=0.1, beta_1=0.9, beta_2=0.
 ↪999, epsilon=1e-08, n_iter_no_change=10,
                                 max_fun=15000)
  #Treinando
  mlp_classifier.fit(x_train, y_train)
  print("Loss do MLP Classifier:", np.mean(mlp_classifier.loss_))

#Avaliação Iterativa: A loss será avaliada em cada estágio do␣
 ↪pré-processamento, para entender como cada etapa afeta o desempenho do modelo
#Loss não será usada para melhorar o pré-processamento, apenas ilustrar o␣
 ↪desempenho
```

[10]:
```
estimar_loss(x,y)
```

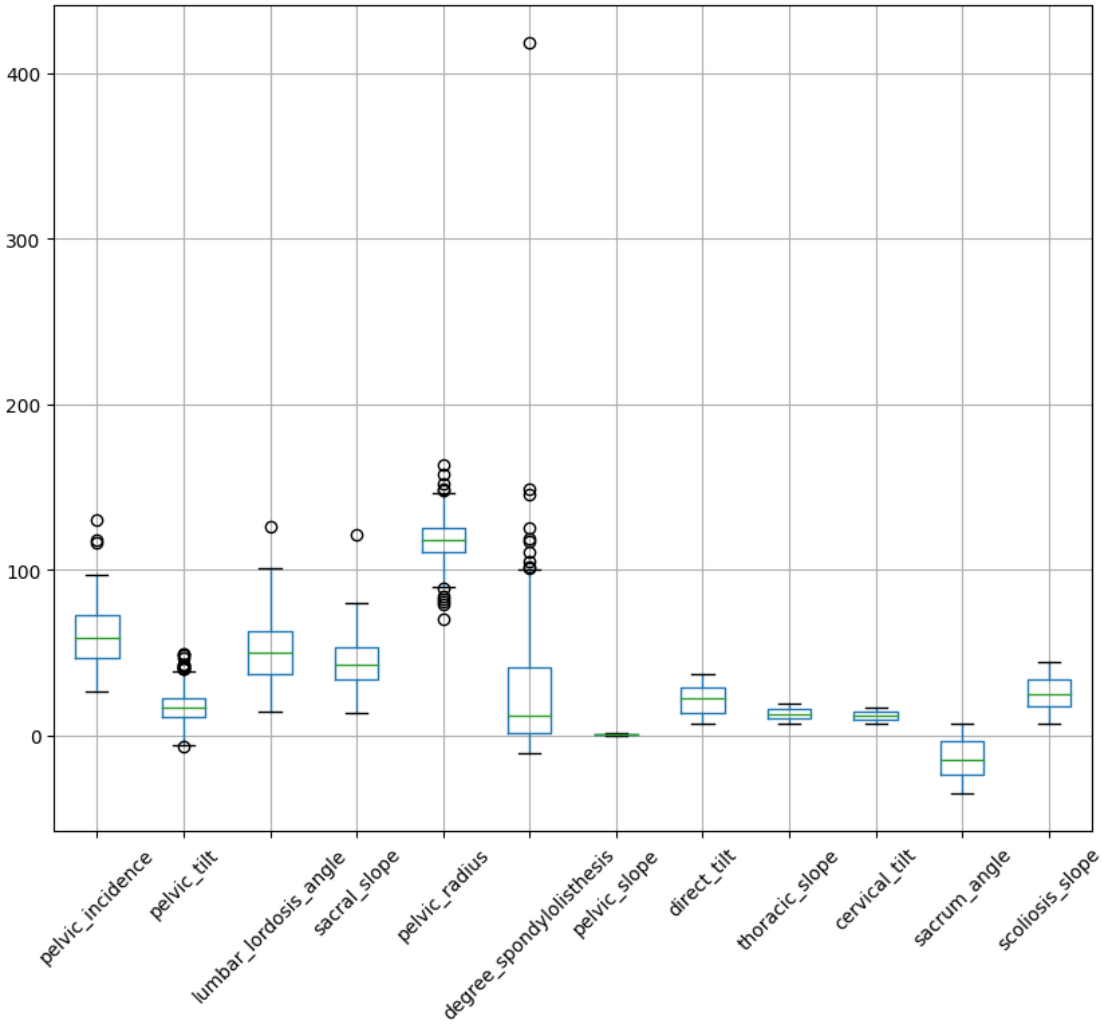
```
Loss do MLP Classifier: 0.27808027948957015

/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
```

###Retirando Outliers

Box Plot

Os box plots são úteis para visualizar a distribuição de valores em cada característica, mostrando a mediana, quartis e outliers. Isso ajuda a identificar discrepâncias nos dados que podem afetar a modelagem.

[11]:
```
#Box plot
plt.figure(figsize=(10, 8))
x.boxplot()
plt.xticks(rotation=45)
plt.show()
```



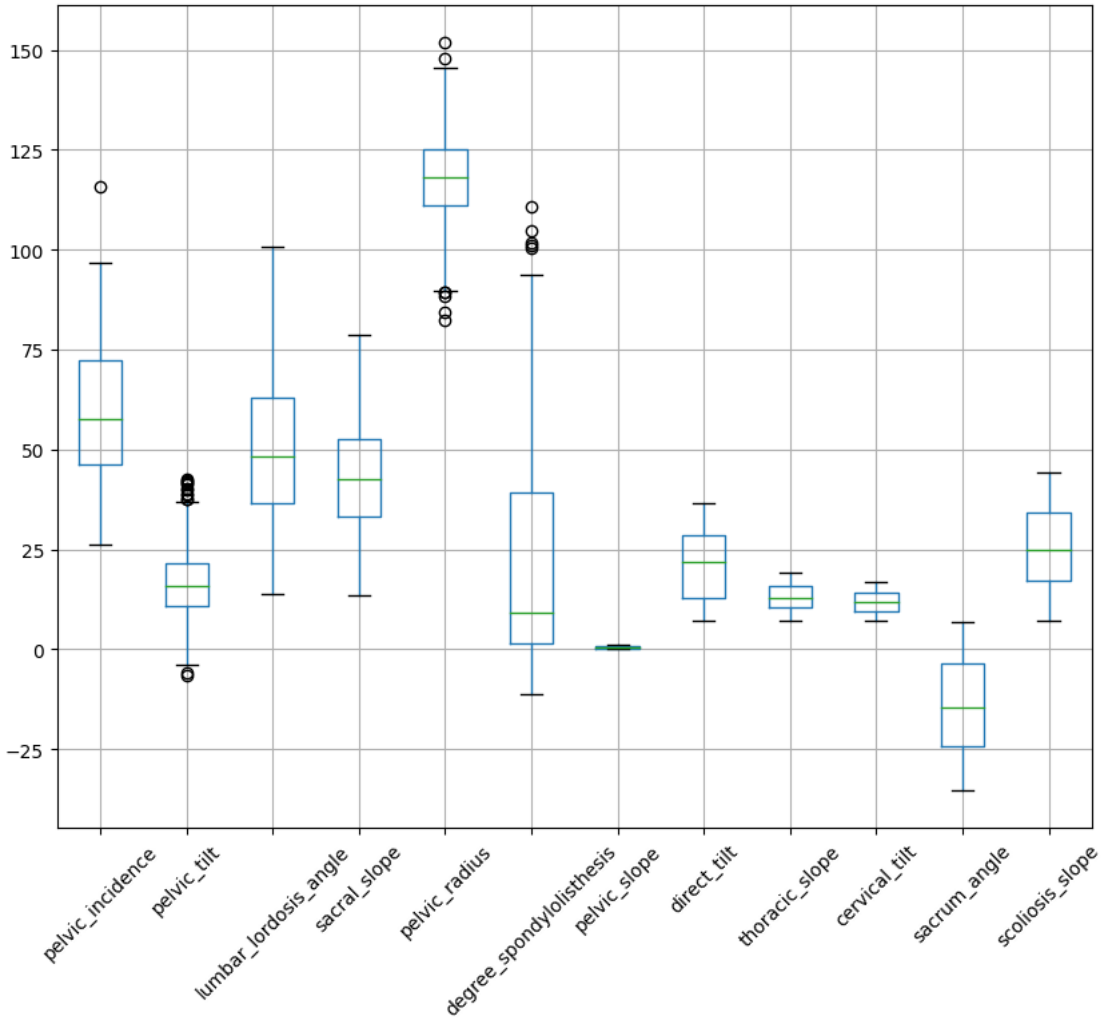
Em um conjunto de dados relativamente pequeno, observamos pelo box plot que a maioria dos outliers está localizada nas proximidades das margens do Intervalo Interquartil (IQR). A abordagem padrão para identificar outliers é a regra dos 1,5 vezes o IQR, mas optamos por aumentar o fator multiplicador para 2, devido ao seu tamanho limitado e à distribuição observada dos outliers.

[12]:
```
#Retirada de outliers
df_clean = df.copy()
for col in x:
```

```
  lower_bound = df_clean[col].quantile(0.25) - 2 * (df_clean[col].quantile(0.
↪75) - df_clean[col].quantile(0.25))
  upper_bound = df_clean[col].quantile(0.75) + 2 * (df_clean[col].quantile(0.
↪75) - df_clean[col].quantile(0.25))
  df_clean = df_clean[(df_clean[col] >= lower_bound) & (df_clean[col] <=␣
↪upper_bound)]
x_clean = df_clean.iloc[:, :-1]
y_clean = df_clean["normality"]
estimar_loss(x_clean, y_clean)
```

```
Loss do MLP Classifier: 0.30581135424572015
```

[13]:
```
#Box plot
plt.figure(figsize=(10, 8))
x_clean.boxplot()
plt.xticks(rotation=45)
plt.show()
```

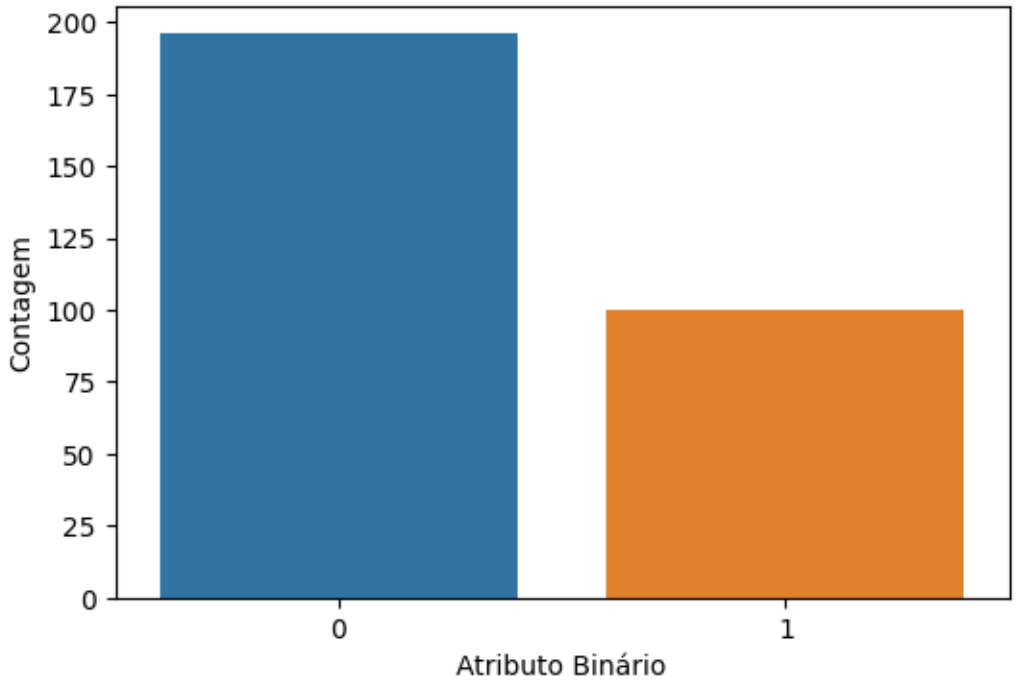


###Balanceamento de classes

Análise dos Atributos Binários

Gráfico de contagem adequado para atributos binários, mostra a distribuição da variável. Relevante para entender o equilíbrio da classe.

[14]:
```
#Análise dos atributos binários
plt.figure(figsize=(6, 4))
sns.countplot(x="normality", data=df_clean)
plt.xlabel("Atributo Binário")
plt.ylabel("Contagem")
plt.show()
```



[15]:
```
print(df_clean["normality"].value_counts())
```

```
0    196
1    100
Name: normality, dtype: int64
```

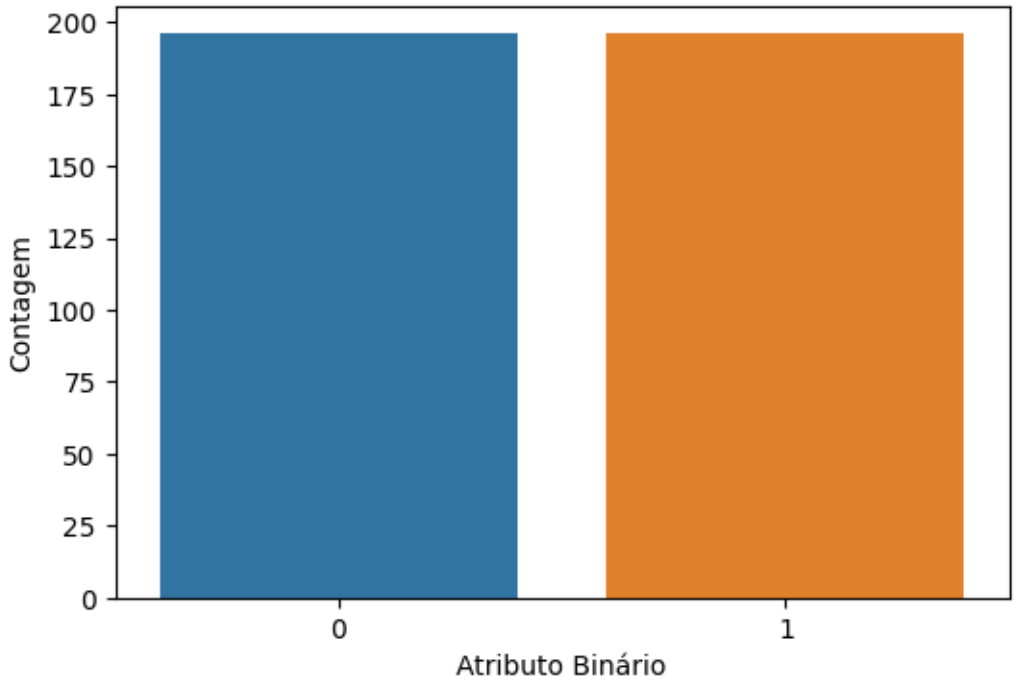
[16]:
```
#Balanceando dados
smote = SMOTE(random_state=42)
x_resampled, y_resampled = smote.fit_resample(x_clean, y_clean)
```

```
balanced_df = pd.concat([pd.DataFrame(x_resampled, columns=x_clean.columns), pd.
  ↪Series(y_resampled, name="normality")], axis=1)
balanced_x = balanced_df.iloc[:, :-1]
balanced_y = balanced_df["normality"]
estimar_loss(balanced_x, balanced_y)
print(balanced_df["normality"].value_counts())
```

```
Loss do MLP Classifier: 0.23469823051296654
0    196
1    196
Name: normality, dtype: int64
```

```
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
```

[17]:
```
#Análise dos atributos binários
plt.figure(figsize=(6, 4))
sns.countplot(x="normality", data=balanced_df)
plt.xlabel("Atributo Binário")
plt.ylabel("Contagem")
plt.show()
```



###Normalização e Padronização

Sumário Estatístico

O resumo estatístico fornece estatísticas descritivas básicas para cada característica no df. Isso inclui a contagem de exemplos, média, desvio padrão, valor mínimo, quartis e valor máximo. Isso ajuda a ter uma visão geral das características e de suas escalas. Pode ser útil para identificar características com escalas muito diferentes e visualizar a necessidade de normalização.

[18]:
```
#Sumário Estatístico
balanced_df.describe()
```

[18]:

	pelvic_incidence	pelvic_tilt	lumbar_lordosis_angle	sacral_slope	\
count	392.000000	392.000000	392.000000	392.000000	
mean	57.810532	15.906806	49.330108	41.903726	
std	15.978789	8.756700	17.283902	11.835850	
min	26.147921	-6.554948	14.000000	13.366931	
25%	44.974529	9.836915	35.999550	33.215251	
50%	54.935914	15.006480	46.048925	40.726254	
75%	69.189420	20.445296	60.036160	50.283827	
max	115.923261	42.689195	100.744220	78.794052	

	pelvic_radius	degree_spondylolisthesis	pelvic_slope	direct_tilt	\
count	392.000000	392.000000	392.000000	392.000000	
mean	119.036809	17.666067	0.471132	21.543445	
std	11.341660	25.107366	0.273188	8.480770	
min	82.456038	-11.058179	0.003220	7.027000	
25%	113.216491	0.790652	0.248929	13.418459	
50%	119.401344	5.387938	0.479896	22.458750	
75%	126.119788	31.388764	0.688529	28.907718	
max	151.839857	110.860782	0.998827	36.743900	

	thoracic_slope	cervical_tilt	sacrum_angle	scoliosis_slope	\
count	392.000000	392.000000	392.000000	392.000000	
mean	13.132572	11.935568	-14.073062	26.305530	
std	3.240146	2.832126	12.145607	10.347865	
min	7.037800	7.030600	-35.287375	7.007900	
25%	10.712725	9.617402	-24.640992	17.577375	
50%	13.106180	11.963525	-14.063307	26.342000	
75%	15.626396	14.259679	-3.933666	34.706236	
max	19.324000	16.821080	6.972071	44.341200	

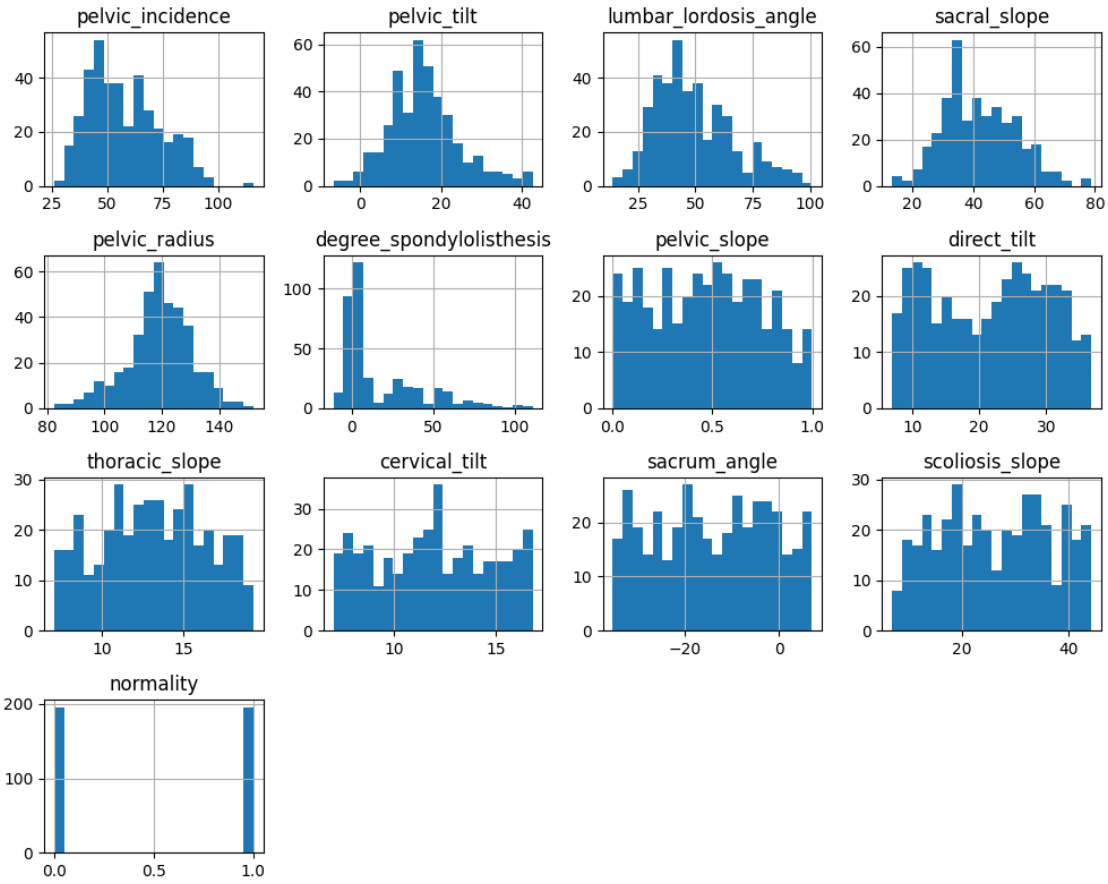
	normality
count	392.000000
mean	0.500000
std	0.500639
min	0.000000
25%	0.000000

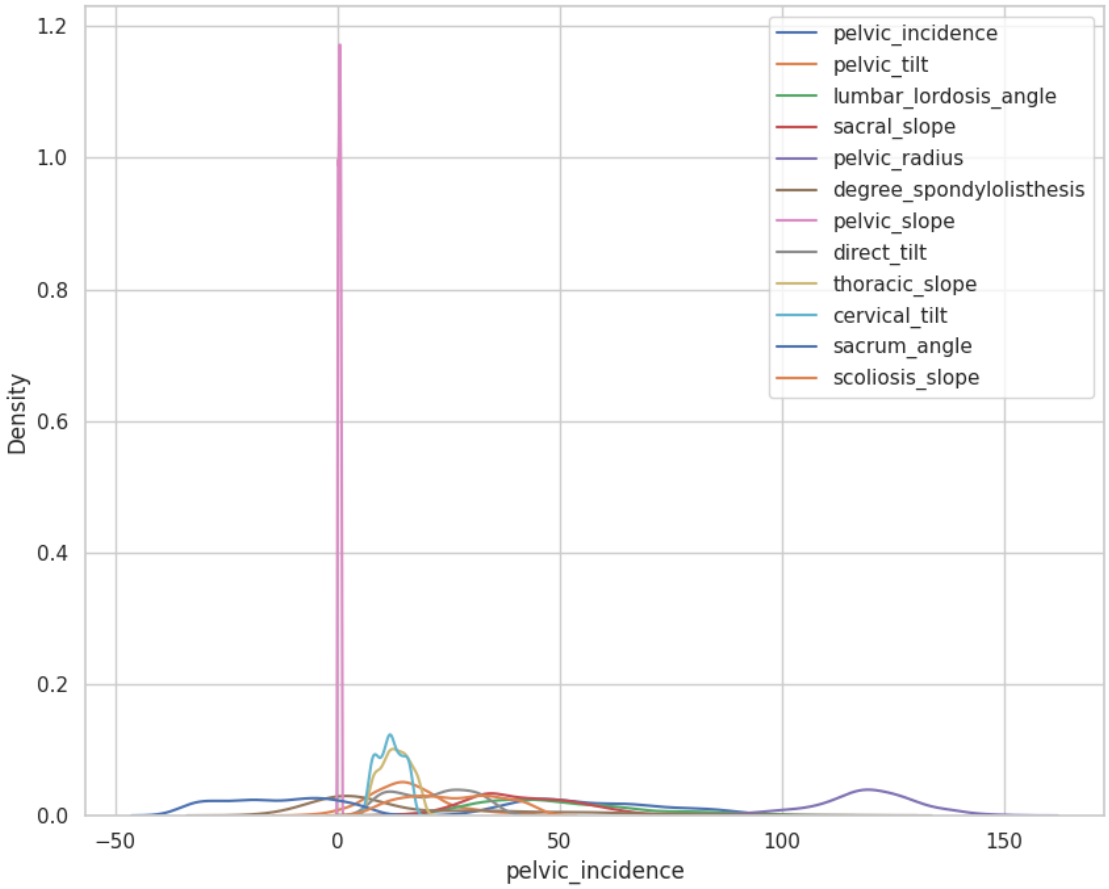
```
50%       0.500000
75%       1.000000
max       1.000000
```

Distribuição de valores

Os histogramas e os gráficos KDE mostram a distribuição dos valores em cada característica. Isso ajuda a entender a forma da distribuição, verificar se as características seguem uma distribuição normal e observar como os valores estão distribuídos. Isso pode influenciar a decisão de normalizar ou padronizar as características.

[19]:
```
#Distribuição de valores
balanced_df.hist(bins=20, figsize=(10, 8))
plt.tight_layout()
plt.show()

sns.set(style="whitegrid")
plt.figure(figsize=(10, 8))
for col in x:
    sns.kdeplot(balanced_df[col], label=col)
plt.legend()
plt.show()
```





[20]:
```
#Normalização
columns_to_normalize =␣
 ↪['pelvic_incidence','pelvic_tilt','lumbar_lordosis_angle','pelvic_radius']␣
 ↪#Distribuição semelhante a normal
scaler = MinMaxScaler()
normalized_df = balanced_df.copy()
normalized_df[columns_to_normalize] = scaler.
 ↪fit_transform(balanced_df[columns_to_normalize])
normalized_x = normalized_df.iloc[:, :-1]
normalized_y = normalized_df["normality"]
estimar_loss(normalized_x, normalized_y)
```

```
Loss do MLP Classifier: 0.20813731852034187
```

```
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
```

```
the optimization hasn't converged yet.
  warnings.warn(
```

[21]:
```
#Padronização
columns_to_standardize =␣
 ↪['pelvic_tilt','sacral_slope','pelvic_radius','pelvic_slope','direct_tilt','thoracic_slope'
                        'cervical_tilt','sacrum_angle','scoliosis_slope']␣
 ↪#Desvio padrão pequeno
scaler = StandardScaler()
standardize_df = normalized_df.copy()
standardize_df[columns_to_standardize] = scaler.
 ↪fit_transform(normalized_df[columns_to_standardize])
standardize_x = standardize_df.iloc[:, :-1]
standardize_y = standardize_df["normality"]
estimar_loss(standardize_x, standardize_y)
```

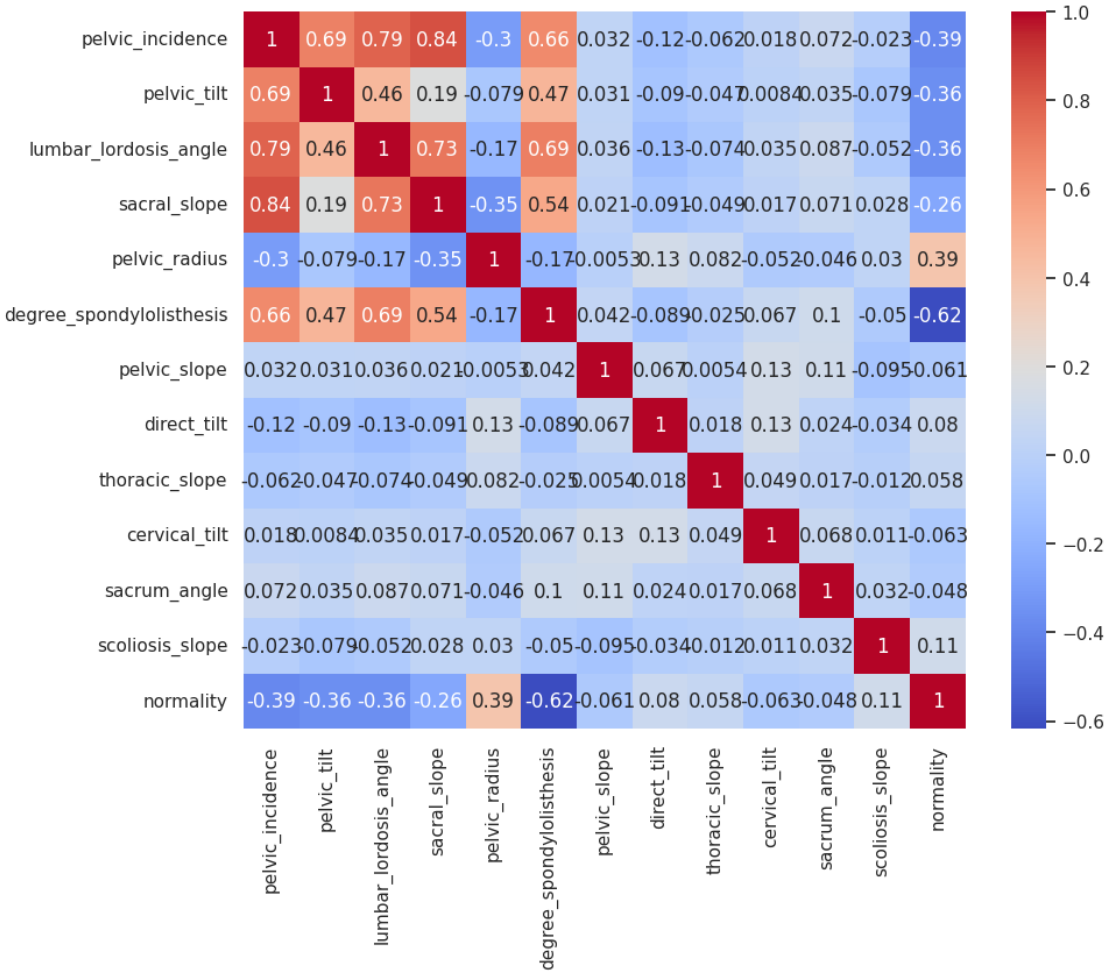
```
Loss do MLP Classifier: 0.15922471077707612

/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
```

###Análise de Atributos

Análise de Correlações

A matriz de correlação e o mapa de calor ajudam a entender as relações lineares entre as características. Isso pode ser útil para identificar pares que estão altamente correlacionadas, o que pode indicar redundância. Em alguns casos, pode ser útil para a seleção de atributos, removendo características altamente correlacionadas.

[22]:
```
#Análise de Correlações
correlation_matrix = standardize_df.corr()
plt.figure(figsize=(10, 8))
sns.heatmap(correlation_matrix, annot=True, cmap="coolwarm")
plt.show()
```



[23]:
```
correlation_matrix = standardize_df.corr()
df_filtered = standardize_df.copy()
corr_threshold = 0.8
#Caso nenhuma coluna tenha correlação de 80% ou mais, ficará o mesmo df
highly_correlated = (correlation_matrix.abs() > corr_threshold) &␣
 ↪(correlation_matrix != 1)
features_to_remove = set()
for col in highly_correlated.columns:
    correlated_cols = highly_correlated.index[highly_correlated[col]].tolist()
    if len(correlated_cols) > 1:
      features_to_remove.add(correlated_cols[1])
df_filtered = df_filtered.drop(columns=features_to_remove)
x_filtered = df_filtered.iloc[:, :-1]
y_filtered = df_filtered["normality"]
estimar_loss(x_filtered,y_filtered)
```

```
Loss do MLP Classifier: 0.15922471077707612
```

```
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
```

##Treinamento e Teste (Valores Usuais)

[24]:
```
#Divisão conjunto treino e test
x_train, x_test, y_train, y_test = train_test_split(x_filtered, y_filtered,␣
 ↪test_size=0.15,random_state=42, shuffle=True)
print(f'x_train: {x_train.shape}')
print(f'x_test: {x_test.shape}')
```

```
x_train: (333, 12)
x_test: (59, 12)
```

[25]:
```
# Criando MLP
losses = []
for i in range(10):
  mlp_classifier = MLPClassifier(hidden_layer_sizes=(100,), activation='relu',␣
 ↪solver='adam', alpha=0.0001,
                                 batch_size='auto', learning_rate='constant',␣
 ↪learning_rate_init=0.001, power_t=0.5,
                                 max_iter=200, shuffle=True, random_state=None,␣
 ↪tol=0.0001, verbose=False,
                                 warm_start=False, momentum=0.9,␣
 ↪nesterovs_momentum=True, early_stopping=False,
                                 validation_fraction=0.1, beta_1=0.9, beta_2=0.
 ↪999, epsilon=1e-08, n_iter_no_change=10,
                                 max_fun=15000)

# Treinando com os parâmetros usuais
  mlp_classifier.fit(x_train, y_train)
  losses.append(mlp_classifier.loss_)
print("Loss do MLP Classifier:", np.mean(losses))
```

```
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
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/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-
```

```
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
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/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
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/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
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/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
```

```
Loss do MLP Classifier: 0.15478382217131986
```

```
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (200) reached and
the optimization hasn't converged yet.
  warnings.warn(
```

[26]:
```python
y_pred = mlp_classifier.predict(x_test)

accuracy = accuracy_score(y_test, y_pred)
print(f"Acurácia do modelo: {accuracy:.2f}")
print("Classification Report")
```

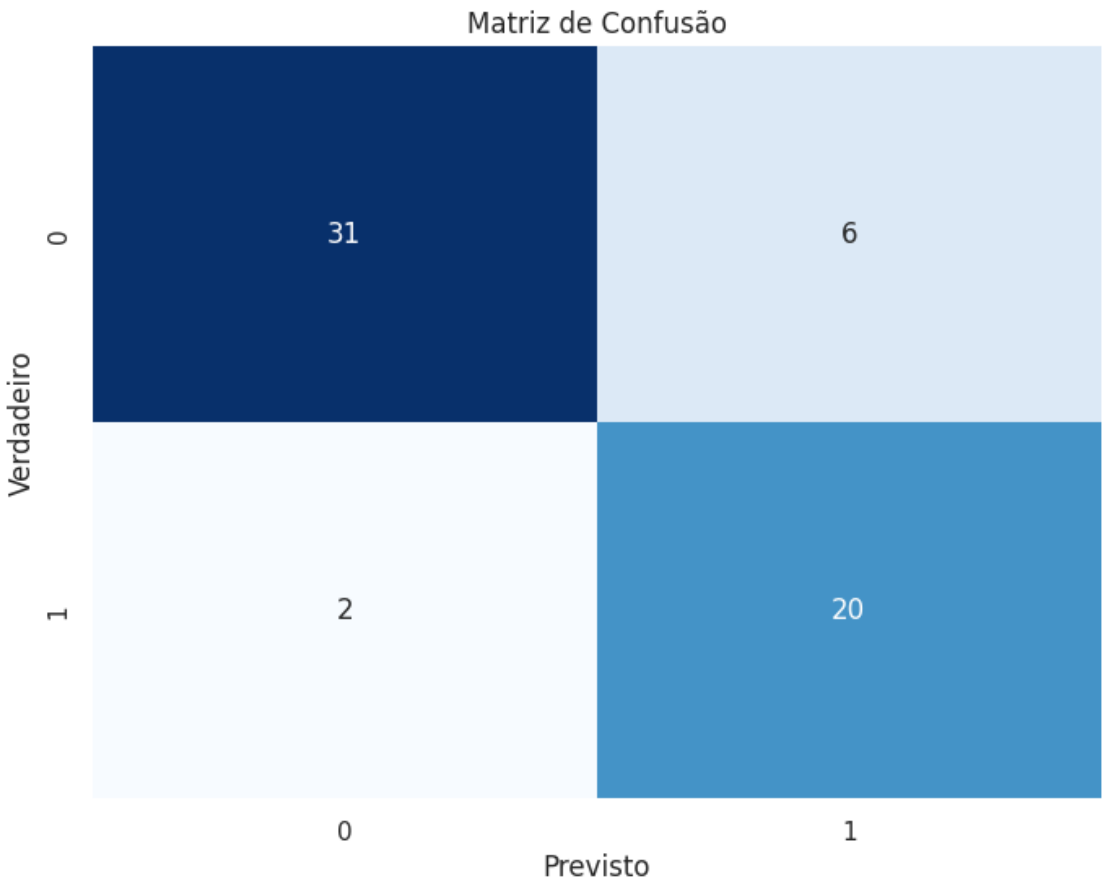
```
print(classification_report(y_test, y_pred))

confusion = confusion_matrix(y_test, y_pred)
plt.figure(figsize=(8, 6))
sns.heatmap(confusion, annot=True, fmt="d", cmap="Blues", cbar=False)
plt.xlabel('Previsto')
plt.ylabel('Verdadeiro')
plt.title('Matriz de Confusão')
plt.show()
```

```
Acurácia do modelo: 0.86
Classification Report
              precision    recall  f1-score   support

           0       0.94      0.84      0.89        37
           1       0.77      0.91      0.83        22

    accuracy                           0.86        59
   macro avg       0.85      0.87      0.86        59
weighted avg       0.88      0.86      0.87        59
```



##Otimização de Hiperparâmetros

[27]:
```
parameters = [Integer(1, 2, name='num_layers'),
              Integer(1, 128, name='nn_fst_layer'),
              Integer(1, 128, name='nn_snd_layer'),
              Categorical(['identity', 'logistic', 'tanh', 'relu'],␣
 ↪name='activation'),
              Categorical(['adam', 'sgd', 'lbfgs'], name='solver'),
              Real(1e-6, 1e-2, prior='log-uniform', name='alpha'),
              Integer(1, 100, name='batch_size'),
              Categorical(['constant', 'invscaling', 'adaptive'],␣
 ↪name='learning_rate'),
              Real(1e-6, 1e-3, prior='log-uniform', name='learning_rate_init'),
              Real(1e-6, 1e-1, prior='log-uniform', name='power_t'),
              Integer(500, 1000, name='max_iter'),
              Real(1e-6, 1e-2, prior='log-uniform', name='tol'),
              Real(0.1, 0.9, name='momentum'),
              Categorical([True, False], name='nesterovs_momentum'),
              Real(0.01, 0.5, name='validation_fraction'),
              Real(0.1, 0.9, name='beta_1'),
              Real(0.001, 0.999, name='beta_2'),
              Real(1e-10, 1e-6, prior='log-uniform', name='epsilon'),
              Integer(1, 100, name='n_iter_no_change'),
              Integer(1, 30000, name='max_fun')]

@use_named_args(parameters)
def objective(**params):
  print(params)
  split = ShuffleSplit(n_splits=2, test_size=0.15)
  indices = [train for  (train, test) in split.split(x_train.to_numpy())]
  data_x, data_y = (x_train.to_numpy())[indices[0]], (y_train.
 ↪to_numpy())[indices[0]]
  split = ShuffleSplit(n_splits=5, test_size=0.2)
  accuracy = []
  for train, test in split.split(data_x):
    if(params["num_layers"] == 1):
        hidden_layer=(params["nn_fst_layer"],)
    if(params["num_layers"] == 2):
        hidden_layer=(params["nn_fst_layer"],params["nn_snd_layer"])

    mlp_classifier = MLPClassifier(hidden_layer_sizes=hidden_layer,␣
 ↪activation=params['activation'], solver=params['solver'],
                                   ␣
 ↪alpha=params['alpha'],batch_size=params['batch_size'],␣
 ↪learning_rate=params['learning_rate'],
```

```
                                   ␣
↪learning_rate_init=params['learning_rate_init'], power_t=params['power_t'],
                                   max_iter=params['max_iter'], shuffle=True,␣
↪random_state=42,
                                   tol=params['tol'], verbose=False,␣
↪warm_start=False, momentum=params['momentum'],
                                   ␣
↪nesterovs_momentum=params['nesterovs_momentum'], early_stopping=False,
                                   ␣
↪validation_fraction=params['validation_fraction'], beta_1=params['beta_1'],
                                   beta_2=params['beta_2'],␣
↪epsilon=params['epsilon'], n_iter_no_change=params['n_iter_no_change'],
                                   max_fun=params['max_fun'])
    mlp_classifier.fit(data_x[train], data_y[train])
    y_pred = mlp_classifier.predict(x_test)
    accuracy.append(accuracy_score(y_test, y_pred))
  return -np.array(accuracy).mean()

result = gbrt_minimize(func=objective, dimensions=parameters, n_calls=50,␣
↪acq_func='EI', n_jobs=-1)
```

```
{'num_layers': 1, 'nn_fst_layer': 60, 'nn_snd_layer': 127, 'activation': 'tanh',
'solver': 'sgd', 'alpha': 5.88441544403621e-05, 'batch_size': 3,
'learning_rate': 'constant', 'learning_rate_init': 2.3067722041927477e-05,
'power_t': 0.007727532937138695, 'max_iter': 926, 'tol': 0.0018203456843217654,
'momentum': 0.7917144386827423, 'nesterovs_momentum': True,
'validation_fraction': 0.016898388706367423, 'beta_1': 0.4382634710461841,
'beta_2': 0.06501378256269795, 'epsilon': 2.5781183456902745e-09,
'n_iter_no_change': 23, 'max_fun': 3991}
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
```

```
{'num_layers': 1, 'nn_fst_layer': 45, 'nn_snd_layer': 41, 'activation':
'identity', 'solver': 'sgd', 'alpha': 1.1877601209901353e-05, 'batch_size': 66,
```

```
'learning_rate': 'adaptive', 'learning_rate_init': 2.274140393662027e-06,
'power_t': 1.2340721299042642e-06, 'max_iter': 871, 'tol':
9.682887870516024e-05, 'momentum': 0.602537047454954, 'nesterovs_momentum':
False, 'validation_fraction': 0.16639604829571056, 'beta_1': 0.2766409431010174,
'beta_2': 0.7972371040231178, 'epsilon': 6.018127261700969e-09,
'n_iter_no_change': 65, 'max_fun': 22614}

/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(

{'num_layers': 2, 'nn_fst_layer': 83, 'nn_snd_layer': 32, 'activation':
'identity', 'solver': 'sgd', 'alpha': 4.139973970124217e-05, 'batch_size': 22,
'learning_rate': 'adaptive', 'learning_rate_init': 3.795405772800814e-05,
'power_t': 2.9489839747915275e-06, 'max_iter': 918, 'tol':
2.3786948305967964e-06, 'momentum': 0.7900788287306341, 'nesterovs_momentum':
False, 'validation_fraction': 0.4648489907041155, 'beta_1': 0.14698774812662319,
'beta_2': 0.7280174135394568, 'epsilon': 1.0017907145630264e-09,
'n_iter_no_change': 98, 'max_fun': 15688}

/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (918) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (918) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
```

```
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (918) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (918) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (918) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
```

```
{'num_layers': 1, 'nn_fst_layer': 51, 'nn_snd_layer': 117, 'activation': 'relu',
'solver': 'lbfgs', 'alpha': 1.6361959240789964e-05, 'batch_size': 46,
'learning_rate': 'invscaling', 'learning_rate_init': 0.00045626619439419105,
'power_t': 0.001078172135901557, 'max_iter': 737, 'tol': 7.709989289908189e-06,
'momentum': 0.8897320239481403, 'nesterovs_momentum': False,
'validation_fraction': 0.4103011189679322, 'beta_1': 0.7796605678351395,
'beta_2': 0.5609382993039985, 'epsilon': 2.0671107882795304e-09,
'n_iter_no_change': 4, 'max_fun': 16581}
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
```

```
{'num_layers': 1, 'nn_fst_layer': 22, 'nn_snd_layer': 75, 'activation': 'relu',
'solver': 'sgd', 'alpha': 4.241119948250281e-05, 'batch_size': 85,
'learning_rate': 'adaptive', 'learning_rate_init': 5.3379963059751865e-06,
'power_t': 0.0015489219462588176, 'max_iter': 904, 'tol': 0.00332957309130042,
'momentum': 0.7619300518448314, 'nesterovs_momentum': True,
'validation_fraction': 0.07704546084379214, 'beta_1': 0.3079211004078749,
'beta_2': 0.5960404962321362, 'epsilon': 1.3264038723795048e-08,
'n_iter_no_change': 23, 'max_fun': 1873}

/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
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/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(

{'num_layers': 2, 'nn_fst_layer': 89, 'nn_snd_layer': 2, 'activation':
'logistic', 'solver': 'adam', 'alpha': 0.0008697479925676794, 'batch_size': 47,
'learning_rate': 'invscaling', 'learning_rate_init': 9.430051157920702e-05,
'power_t': 0.013135679757409358, 'max_iter': 821, 'tol': 0.0004987627123289927,
'momentum': 0.77022837742721, 'nesterovs_momentum': True, 'validation_fraction':
0.13089400474257853, 'beta_1': 0.380233449752312, 'beta_2': 0.3362030111887359,
'epsilon': 9.937103537980937e-09, 'n_iter_no_change': 27, 'max_fun': 1838}

/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
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  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(

{'num_layers': 1, 'nn_fst_layer': 46, 'nn_snd_layer': 103, 'activation':
```

```
'logistic', 'solver': 'sgd', 'alpha': 5.498027286508785e-05, 'batch_size': 5,
'learning_rate': 'adaptive', 'learning_rate_init': 1.6883663334536355e-05,
'power_t': 0.03175213241811415, 'max_iter': 806, 'tol': 0.00036123269883329203,
'momentum': 0.2278280821922594, 'nesterovs_momentum': True,
'validation_fraction': 0.45049621212871216, 'beta_1': 0.8889545194687201,
'beta_2': 0.4915745011681681, 'epsilon': 6.357449413067958e-10,
'n_iter_no_change': 88, 'max_fun': 20840}
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
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  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
```

```
{'num_layers': 1, 'nn_fst_layer': 116, 'nn_snd_layer': 76, 'activation': 'tanh',
'solver': 'lbfgs', 'alpha': 1.0519335361472198e-05, 'batch_size': 100,
'learning_rate': 'adaptive', 'learning_rate_init': 1.1391938503343714e-05,
'power_t': 0.00025900123451145146, 'max_iter': 722, 'tol':
1.420404835782932e-06, 'momentum': 0.1204350167925215, 'nesterovs_momentum':
True, 'validation_fraction': 0.3183702392633542, 'beta_1': 0.29667217801313794,
'beta_2': 0.5336367255136976, 'epsilon': 9.472053166883784e-07,
'n_iter_no_change': 79, 'max_fun': 21149}
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
```

```
{'num_layers': 2, 'nn_fst_layer': 1, 'nn_snd_layer': 49, 'activation': 'tanh',
```

```
'solver': 'lbfgs', 'alpha': 0.0021986578352676343, 'batch_size': 29,
'learning_rate': 'adaptive', 'learning_rate_init': 0.0005638915826335362,
'power_t': 7.599843090484911e-06, 'max_iter': 558, 'tol':
0.00025565826955850667, 'momentum': 0.7299700543551247, 'nesterovs_momentum':
False, 'validation_fraction': 0.19676386869551937, 'beta_1': 0.7267982327875118,
'beta_2': 0.6139781064049253, 'epsilon': 1.6298015487181577e-09,
'n_iter_no_change': 48, 'max_fun': 15614}

/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:541:
ConvergenceWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
  self.n_iter_ = _check_optimize_result("lbfgs", opt_res, self.max_iter)
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(

{'num_layers': 1, 'nn_fst_layer': 10, 'nn_snd_layer': 68, 'activation': 'tanh',
'solver': 'adam', 'alpha': 2.1423110212607217e-06, 'batch_size': 76,
'learning_rate': 'invscaling', 'learning_rate_init': 7.085499671362183e-06,
'power_t': 4.473275926910136e-06, 'max_iter': 802, 'tol':
1.1901739046132499e-05, 'momentum': 0.7892074215503307, 'nesterovs_momentum':
True, 'validation_fraction': 0.284839368346265, 'beta_1': 0.10843120727651057,
'beta_2': 0.13990247407711354, 'epsilon': 9.482333510271225e-10,
'n_iter_no_change': 61, 'max_fun': 16715}

/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (802) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
```

```
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (802) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (802) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (802) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (802) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
```

```
{'num_layers': 2, 'nn_fst_layer': 101, 'nn_snd_layer': 10, 'activation':
'logistic', 'solver': 'lbfgs', 'alpha': 1.3379953010677393e-05, 'batch_size':
25, 'learning_rate': 'invscaling', 'learning_rate_init': 0.0003498985410027283,
'power_t': 2.802592233694136e-06, 'max_iter': 535, 'tol': 4.070222354543135e-06,
'momentum': 0.3695986645243565, 'nesterovs_momentum': False,
'validation_fraction': 0.39384484150442783, 'beta_1': 0.6632818034324466,
'beta_2': 0.6759666900791373, 'epsilon': 9.627757172603179e-08,
'n_iter_no_change': 49, 'max_fun': 1355}
```

```
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:541:
ConvergenceWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
```

```
  self.n_iter_ = _check_optimize_result("lbfgs", opt_res, self.max_iter)
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:541:
ConvergenceWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
  self.n_iter_ = _check_optimize_result("lbfgs", opt_res, self.max_iter)
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:541:
ConvergenceWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
  self.n_iter_ = _check_optimize_result("lbfgs", opt_res, self.max_iter)
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:541:
ConvergenceWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
  self.n_iter_ = _check_optimize_result("lbfgs", opt_res, self.max_iter)
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(

{'num_layers': 2, 'nn_fst_layer': 115, 'nn_snd_layer': 4, 'activation':
'logistic', 'solver': 'adam', 'alpha': 2.1616288010444874e-05, 'batch_size': 33,
'learning_rate': 'adaptive', 'learning_rate_init': 1.7986883675958322e-05,
'power_t': 0.053831916980443775, 'max_iter': 676, 'tol': 2.3596644227265403e-06,
'momentum': 0.7050435659243472, 'nesterovs_momentum': False,
'validation_fraction': 0.48033661782577086, 'beta_1': 0.13662834741667487,
'beta_2': 0.1613693482873648, 'epsilon': 7.170585661359014e-08,
```

```
'n_iter_no_change': 2, 'max_fun': 20412}
```

```
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (676) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (676) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (676) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (676) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (676) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
```

```
{'num_layers': 1, 'nn_fst_layer': 18, 'nn_snd_layer': 19, 'activation': 'tanh',
'solver': 'lbfgs', 'alpha': 2.112050295767597e-06, 'batch_size': 15,
'learning_rate': 'invscaling', 'learning_rate_init': 0.0004148327807961496,
'power_t': 7.849278435393835e-06, 'max_iter': 788, 'tol':
1.1327888900745185e-06, 'momentum': 0.8818170220952737, 'nesterovs_momentum':
False, 'validation_fraction': 0.0614671119693977, 'beta_1': 0.3603829041591122,
```

```
'beta_2': 0.18071505493236537, 'epsilon': 4.271569514093914e-08,
'n_iter_no_change': 21, 'max_fun': 27195}

/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(

{'num_layers': 1, 'nn_fst_layer': 86, 'nn_snd_layer': 32, 'activation':
'identity', 'solver': 'lbfgs', 'alpha': 5.749255424138611e-05, 'batch_size': 12,
'learning_rate': 'adaptive', 'learning_rate_init': 0.000492188722966709,
'power_t': 2.512421531670059e-06, 'max_iter': 650, 'tol': 2.85238974749995e-06,
'momentum': 0.886510134074865, 'nesterovs_momentum': True,
'validation_fraction': 0.18309366365893817, 'beta_1': 0.5621079557586488,
'beta_2': 0.9972134882195675, 'epsilon': 1.466086479385698e-08,
'n_iter_no_change': 87, 'max_fun': 22071}

/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(

{'num_layers': 2, 'nn_fst_layer': 121, 'nn_snd_layer': 61, 'activation': 'tanh',
'solver': 'lbfgs', 'alpha': 1.1286970678831525e-06, 'batch_size': 61,
'learning_rate': 'constant', 'learning_rate_init': 0.00035314530732334323,
'power_t': 0.07015018554385961, 'max_iter': 513, 'tol': 3.6470766734888923e-06,
'momentum': 0.896892387083247, 'nesterovs_momentum': True,
'validation_fraction': 0.050540201158859856, 'beta_1': 0.3135295159676842,
```

```
'beta_2': 0.6826145157151667, 'epsilon': 9.550905840330139e-09,
'n_iter_no_change': 17, 'max_fun': 24333}

/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(

{'num_layers': 1, 'nn_fst_layer': 34, 'nn_snd_layer': 2, 'activation':
'logistic', 'solver': 'lbfgs', 'alpha': 3.405898228107482e-05, 'batch_size': 35,
'learning_rate': 'invscaling', 'learning_rate_init': 0.0005172017823446524,
'power_t': 0.00016576302385372762, 'max_iter': 645, 'tol': 0.005742639713051132,
'momentum': 0.2067213717746608, 'nesterovs_momentum': False,
'validation_fraction': 0.06289361667981307, 'beta_1': 0.20314606228476778,
'beta_2': 0.6001142678523886, 'epsilon': 1.345047922855992e-08,
'n_iter_no_change': 80, 'max_fun': 28734}

/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(

{'num_layers': 2, 'nn_fst_layer': 18, 'nn_snd_layer': 108, 'activation':
'identity', 'solver': 'lbfgs', 'alpha': 1.2060404831452679e-05, 'batch_size':
23, 'learning_rate': 'adaptive', 'learning_rate_init': 0.00047894930050769235,
'power_t': 0.000785669274573418, 'max_iter': 527, 'tol': 0.0012582038401450872,
'momentum': 0.2804046880026875, 'nesterovs_momentum': True,
'validation_fraction': 0.4621679438966972, 'beta_1': 0.8848176348392771,
```

```
'beta_2': 0.5046519155689181, 'epsilon': 4.116046150993685e-08,
'n_iter_no_change': 66, 'max_fun': 15696}

/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(

{'num_layers': 1, 'nn_fst_layer': 21, 'nn_snd_layer': 68, 'activation':
'identity', 'solver': 'adam', 'alpha': 0.009674485960232402, 'batch_size': 86,
'learning_rate': 'invscaling', 'learning_rate_init': 0.00013908932641794778,
'power_t': 1.17926048739687e-05, 'max_iter': 703, 'tol': 4.210457872565849e-05,
'momentum': 0.8244025359759314, 'nesterovs_momentum': True,
'validation_fraction': 0.14705565225768896, 'beta_1': 0.5265188131909713,
'beta_2': 0.5021912661952145, 'epsilon': 2.395913240317723e-09,
'n_iter_no_change': 98, 'max_fun': 18563}

/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (703) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (703) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (703) reached and
the optimization hasn't converged yet.
  warnings.warn(
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (703) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (703) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
```

```
{'num_layers': 1, 'nn_fst_layer': 51, 'nn_snd_layer': 29, 'activation': 'relu',
'solver': 'lbfgs', 'alpha': 0.00011910927105308944, 'batch_size': 11,
'learning_rate': 'adaptive', 'learning_rate_init': 0.00034691717516875545,
'power_t': 1.033481728535233e-06, 'max_iter': 876, 'tol': 0.0002692065314271982,
'momentum': 0.4011657396095305, 'nesterovs_momentum': False,
'validation_fraction': 0.4778576104382654, 'beta_1': 0.8208297649772928,
'beta_2': 0.3446075407302217, 'epsilon': 2.7822211508285247e-09,
'n_iter_no_change': 4, 'max_fun': 14300}
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
```

```
{'num_layers': 2, 'nn_fst_layer': 96, 'nn_snd_layer': 10, 'activation':
'identity', 'solver': 'lbfgs', 'alpha': 4.740844903282307e-06, 'batch_size': 55,
'learning_rate': 'adaptive', 'learning_rate_init': 3.252762078115642e-05,
'power_t': 6.061736710510986e-05, 'max_iter': 872, 'tol': 0.007062542023018805,
```

```
'momentum': 0.584086512527769, 'nesterovs_momentum': False,
'validation_fraction': 0.4722275243812396, 'beta_1': 0.8926904432251009,
'beta_2': 0.747375529612447, 'epsilon': 1.4212142223051518e-10,
'n_iter_no_change': 22, 'max_fun': 29651}

/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(

{'num_layers': 2, 'nn_fst_layer': 22, 'nn_snd_layer': 54, 'activation': 'relu',
'solver': 'adam', 'alpha': 2.594243857195582e-05, 'batch_size': 94,
'learning_rate': 'constant', 'learning_rate_init': 0.0004731448484768677,
'power_t': 3.0146691701791363e-05, 'max_iter': 627, 'tol':
3.3475464703980707e-06, 'momentum': 0.329275821606849, 'nesterovs_momentum':
True, 'validation_fraction': 0.2928875319401799, 'beta_1': 0.41530707110142095,
'beta_2': 0.45871292798241287, 'epsilon': 8.449893997402094e-09,
'n_iter_no_change': 70, 'max_fun': 29816}

/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (627) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (627) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (627) reached and
```

```
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (627) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (627) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(

{'num_layers': 2, 'nn_fst_layer': 42, 'nn_snd_layer': 71, 'activation':
'logistic', 'solver': 'lbfgs', 'alpha': 0.0016797304312511862, 'batch_size': 52,
'learning_rate': 'invscaling', 'learning_rate_init': 0.0005208012653703742,
'power_t': 1.3499894600491117e-06, 'max_iter': 801, 'tol':
2.437733590381186e-06, 'momentum': 0.805771513687481, 'nesterovs_momentum':
False, 'validation_fraction': 0.4688985210894677, 'beta_1': 0.2334915810999844,
'beta_2': 0.9522742442962157, 'epsilon': 3.351998611086149e-07,
'n_iter_no_change': 53, 'max_fun': 23205}

/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:541:
ConvergenceWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
  self.n_iter_ = _check_optimize_result("lbfgs", opt_res, self.max_iter)
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:541:
ConvergenceWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
```

```
  self.n_iter_ = _check_optimize_result("lbfgs", opt_res, self.max_iter)
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:541:
ConvergenceWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
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/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:541:
ConvergenceWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
  self.n_iter_ = _check_optimize_result("lbfgs", opt_res, self.max_iter)
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(

{'num_layers': 1, 'nn_fst_layer': 113, 'nn_snd_layer': 62, 'activation': 'relu',
'solver': 'sgd', 'alpha': 0.006894372314805862, 'batch_size': 73,
'learning_rate': 'constant', 'learning_rate_init': 0.0008464565005359459,
'power_t': 0.0006972411333659098, 'max_iter': 816, 'tol': 2.569687153610582e-06,
'momentum': 0.5118761911444966, 'nesterovs_momentum': True,
'validation_fraction': 0.46221218086219124, 'beta_1': 0.8178373757038014,
'beta_2': 0.38963959670224735, 'epsilon': 2.149796704389698e-08,
'n_iter_no_change': 74, 'max_fun': 17205}

/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (816) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
```

```
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (816) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (816) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (816) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (816) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
```

```
{'num_layers': 1, 'nn_fst_layer': 14, 'nn_snd_layer': 119, 'activation': 'tanh',
'solver': 'adam', 'alpha': 0.000308136459092429, 'batch_size': 57,
'learning_rate': 'invscaling', 'learning_rate_init': 0.0005028745462816259,
'power_t': 0.01089259122905439, 'max_iter': 555, 'tol': 0.008413326971707265,
'momentum': 0.6477572199130901, 'nesterovs_momentum': False,
'validation_fraction': 0.1684744758903124, 'beta_1': 0.49234940338375144,
'beta_2': 0.24665291562112376, 'epsilon': 6.966449674834443e-10,
'n_iter_no_change': 46, 'max_fun': 22800}
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
```

{'num_layers': 1, 'nn_fst_layer': 16, 'nn_snd_layer': 128, 'activation':
'logistic', 'solver': 'lbfgs', 'alpha': 0.00012982676200121193, 'batch_size':
74, 'learning_rate': 'adaptive', 'learning_rate_init': 7.442856566988715e-05,
'power_t': 0.0007675632758251248, 'max_iter': 715, 'tol':
0.00013397093968413974, 'momentum': 0.8729463886523248, 'nesterovs_momentum':
True, 'validation_fraction': 0.2911679508714933, 'beta_1': 0.2902653024442371,
'beta_2': 0.24387252966704778, 'epsilon': 8.445173603488189e-10,
'n_iter_no_change': 95, 'max_fun': 939}

```
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
```

{'num_layers': 1, 'nn_fst_layer': 34, 'nn_snd_layer': 107, 'activation': 'relu',
'solver': 'adam', 'alpha': 0.00010798039710608108, 'batch_size': 5,
'learning_rate': 'adaptive', 'learning_rate_init': 0.0007294646442744826,
'power_t': 0.02493782004753923, 'max_iter': 1000, 'tol': 1.1866092701728781e-06,
'momentum': 0.8490665790658918, 'nesterovs_momentum': True,
'validation_fraction': 0.24065670002224648, 'beta_1': 0.3597433085209999,
'beta_2': 0.7448218843242942, 'epsilon': 2.0780621985513346e-09,
'n_iter_no_change': 4, 'max_fun': 24581}

```
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
```

```
{'num_layers': 2, 'nn_fst_layer': 26, 'nn_snd_layer': 7, 'activation':
'logistic', 'solver': 'sgd', 'alpha': 0.000475143786324968, 'batch_size': 34,
'learning_rate': 'adaptive', 'learning_rate_init': 8.229590554300628e-06,
'power_t': 0.00072171947421128, 'max_iter': 681, 'tol': 1.1473614023347014e-06,
'momentum': 0.8700972846925952, 'nesterovs_momentum': False,
'validation_fraction': 0.16536690365896078, 'beta_1': 0.15058899930599196,
'beta_2': 0.061028950331565794, 'epsilon': 1.4957411233533675e-08,
'n_iter_no_change': 86, 'max_fun': 4346}
```

```
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (681) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (681) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (681) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (681) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
```

```
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (681) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(

{'num_layers': 1, 'nn_fst_layer': 30, 'nn_snd_layer': 49, 'activation':
'logistic', 'solver': 'lbfgs', 'alpha': 0.0001668612518240782, 'batch_size': 57,
'learning_rate': 'constant', 'learning_rate_init': 0.0001687235340116945,
'power_t': 0.00038788259038240755, 'max_iter': 921, 'tol':
3.6657544270745957e-06, 'momentum': 0.34418256406549197, 'nesterovs_momentum':
False, 'validation_fraction': 0.1792853066681872, 'beta_1': 0.5815105524089883,
'beta_2': 0.05281534169268936, 'epsilon': 1.2783618786023877e-07,
'n_iter_no_change': 35, 'max_fun': 7127}

/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(

{'num_layers': 1, 'nn_fst_layer': 47, 'nn_snd_layer': 1, 'activation': 'tanh',
'solver': 'lbfgs', 'alpha': 3.084674812171382e-05, 'batch_size': 95,
'learning_rate': 'invscaling', 'learning_rate_init': 1.0990419033612767e-05,
'power_t': 0.0003013836579687606, 'max_iter': 990, 'tol':
1.0192918404843294e-06, 'momentum': 0.8553560659661043, 'nesterovs_momentum':
True, 'validation_fraction': 0.10948147601121767, 'beta_1': 0.7837449632808742,
'beta_2': 0.4774156288954914, 'epsilon': 3.3899316600740993e-09,
'n_iter_no_change': 89, 'max_fun': 4208}

/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
```

```
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
```

```
{'num_layers': 2, 'nn_fst_layer': 107, 'nn_snd_layer': 3, 'activation':
'identity', 'solver': 'sgd', 'alpha': 0.0009658830272040186, 'batch_size': 40,
'learning_rate': 'adaptive', 'learning_rate_init': 3.998793580319288e-05,
'power_t': 0.0009623989363446846, 'max_iter': 702, 'tol':
0.00012716460235978863, 'momentum': 0.527081614004831, 'nesterovs_momentum':
False, 'validation_fraction': 0.38670834477895466, 'beta_1': 0.1356132356834052,
'beta_2': 0.03502020855760833, 'epsilon': 4.886967410053296e-07,
'n_iter_no_change': 54, 'max_fun': 23880}
```

```
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (702) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (702) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (702) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (702) reached and
the optimization hasn't converged yet.
  warnings.warn(
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(

{'num_layers': 2, 'nn_fst_layer': 7, 'nn_snd_layer': 97, 'activation':
'logistic', 'solver': 'adam', 'alpha': 1.3872334990713376e-05, 'batch_size': 36,
'learning_rate': 'constant', 'learning_rate_init': 0.00046444932031718453,
'power_t': 1.4152801458853821e-05, 'max_iter': 563, 'tol':
9.779188387762357e-06, 'momentum': 0.7913097143927444, 'nesterovs_momentum':
True, 'validation_fraction': 0.32772520754250345, 'beta_1': 0.7733133010335694,
'beta_2': 0.013007929339598986, 'epsilon': 1.0594344940491364e-09,
'n_iter_no_change': 19, 'max_fun': 26202}

/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (563) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (563) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (563) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(

{'num_layers': 2, 'nn_fst_layer': 116, 'nn_snd_layer': 1, 'activation':
'logistic', 'solver': 'adam', 'alpha': 0.0004141801203893608, 'batch_size': 74,
'learning_rate': 'constant', 'learning_rate_init': 0.00016554914938680316,
'power_t': 0.00019857513491019547, 'max_iter': 794, 'tol':
1.084887051471218e-06, 'momentum': 0.8238782925766223, 'nesterovs_momentum':
```

```
True, 'validation_fraction': 0.3903922356204036, 'beta_1': 0.7194510556777169,
'beta_2': 0.6267622664385594, 'epsilon': 2.8916227502704014e-08,
'n_iter_no_change': 30, 'max_fun': 4673}

/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (794) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (794) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (794) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (794) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (794) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(

{'num_layers': 2, 'nn_fst_layer': 104, 'nn_snd_layer': 94, 'activation': 'tanh',
'solver': 'adam', 'alpha': 0.0017099349733236445, 'batch_size': 99,
'learning_rate': 'invscaling', 'learning_rate_init': 3.1054181906728564e-06,
'power_t': 1.5658118886966435e-05, 'max_iter': 613, 'tol':
```

```
1.591055316095649e-06, 'momentum': 0.21585562382330076, 'nesterovs_momentum':
False, 'validation_fraction': 0.2424295192721184, 'beta_1': 0.10690438365046379,
'beta_2': 0.44446052974837263, 'epsilon': 1.265868356133057e-08,
'n_iter_no_change': 74, 'max_fun': 513}
```

```
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (613) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
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  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (613) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
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  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (613) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
```

```
{'num_layers': 2, 'nn_fst_layer': 48, 'nn_snd_layer': 51, 'activation':
'identity', 'solver': 'sgd', 'alpha': 9.36998515382639e-06, 'batch_size': 65,
'learning_rate': 'constant', 'learning_rate_init': 0.0006200093960852048,
```

```
'power_t': 0.0036809770744178345, 'max_iter': 610, 'tol': 1.050390949857825e-06,
'momentum': 0.3852898639214104, 'nesterovs_momentum': False,
'validation_fraction': 0.4474348785163896, 'beta_1': 0.3701868039772547,
'beta_2': 0.06400638072189371, 'epsilon': 6.155855445396255e-10,
'n_iter_no_change': 60, 'max_fun': 25394}
```

```
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (610) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (610) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
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/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
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/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
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/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
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/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (610) reached and
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  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
```

```
{'num_layers': 1, 'nn_fst_layer': 89, 'nn_snd_layer': 3, 'activation': 'relu',
'solver': 'lbfgs', 'alpha': 0.0006895801766643896, 'batch_size': 40,
```

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'learning_rate': 'invscaling', 'learning_rate_init': 6.2445968394405465e-06,
'power_t': 0.001971297258730687, 'max_iter': 903, 'tol': 3.29905163806113e-05,
'momentum': 0.3758438040292338, 'nesterovs_momentum': True,
'validation_fraction': 0.18979890235100733, 'beta_1': 0.20203970988550649,
'beta_2': 0.009238542893497147, 'epsilon': 1.1036028383920912e-09,
'n_iter_no_change': 67, 'max_fun': 1245}

/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(

{'num_layers': 2, 'nn_fst_layer': 15, 'nn_snd_layer': 7, 'activation':
'identity', 'solver': 'lbfgs', 'alpha': 1.0224547404268236e-05, 'batch_size':
93, 'learning_rate': 'invscaling', 'learning_rate_init': 1.515761420949963e-06,
'power_t': 2.9807748466048407e-05, 'max_iter': 904, 'tol':
7.006076218023047e-06, 'momentum': 0.8945319621795963, 'nesterovs_momentum':
False, 'validation_fraction': 0.3954219210455589, 'beta_1': 0.4532791281479198,
'beta_2': 0.9273728858607656, 'epsilon': 3.3509276190784446e-09,
'n_iter_no_change': 19, 'max_fun': 14881}

/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
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  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(

{'num_layers': 1, 'nn_fst_layer': 37, 'nn_snd_layer': 18, 'activation':
'identity', 'solver': 'lbfgs', 'alpha': 0.0022079823443064413, 'batch_size': 21,
```

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'learning_rate': 'adaptive', 'learning_rate_init': 7.736380174350102e-06,
'power_t': 0.00010783547698178213, 'max_iter': 953, 'tol':
1.1443236075180356e-06, 'momentum': 0.39367692943721677, 'nesterovs_momentum':
False, 'validation_fraction': 0.4852152290347929, 'beta_1': 0.4827282183799628,
'beta_2': 0.43371179218809625, 'epsilon': 3.7814155401423247e-10,
'n_iter_no_change': 8, 'max_fun': 5874}

/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(

{'num_layers': 1, 'nn_fst_layer': 24, 'nn_snd_layer': 128, 'activation': 'tanh',
'solver': 'lbfgs', 'alpha': 0.004034870147212609, 'batch_size': 91,
'learning_rate': 'invscaling', 'learning_rate_init': 6.135122279364826e-06,
'power_t': 0.0007315029466703644, 'max_iter': 979, 'tol': 4.599987674898544e-05,
'momentum': 0.4106955877308577, 'nesterovs_momentum': True,
'validation_fraction': 0.12454833787123099, 'beta_1': 0.17024386540944203,
'beta_2': 0.6785510229527744, 'epsilon': 3.105073072601127e-10,
'n_iter_no_change': 100, 'max_fun': 24977}

/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
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  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(

{'num_layers': 2, 'nn_fst_layer': 18, 'nn_snd_layer': 123, 'activation': 'relu',
'solver': 'lbfgs', 'alpha': 0.0039214259481806695, 'batch_size': 47,
```

```
'learning_rate': 'invscaling', 'learning_rate_init': 9.774909771719096e-05,
'power_t': 0.010628339028371311, 'max_iter': 557, 'tol': 1.7285159394162326e-06,
'momentum': 0.5447073759450191, 'nesterovs_momentum': False,
'validation_fraction': 0.07407387975407902, 'beta_1': 0.12718912084129652,
'beta_2': 0.47886259865985237, 'epsilon': 1.044795763592367e-09,
'n_iter_no_change': 5, 'max_fun': 2991}

/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:541:
ConvergenceWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
  self.n_iter_ = _check_optimize_result("lbfgs", opt_res, self.max_iter)
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:541:
ConvergenceWarning: lbfgs failed to converge (status=1):
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    https://scikit-learn.org/stable/modules/preprocessing.html
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/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:541:
ConvergenceWarning: lbfgs failed to converge (status=1):
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    https://scikit-learn.org/stable/modules/preprocessing.html
  self.n_iter_ = _check_optimize_result("lbfgs", opt_res, self.max_iter)
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(

{'num_layers': 1, 'nn_fst_layer': 58, 'nn_snd_layer': 6, 'activation':
'logistic', 'solver': 'lbfgs', 'alpha': 0.008097058126103977, 'batch_size': 99,
```

```
'learning_rate': 'adaptive', 'learning_rate_init': 2.6285178013273782e-06,
'power_t': 6.291164358915712e-06, 'max_iter': 620, 'tol':
4.3351319837638245e-05, 'momentum': 0.8299321182382878, 'nesterovs_momentum':
False, 'validation_fraction': 0.11497723953627345, 'beta_1': 0.3184117785718311,
'beta_2': 0.05468202427260927, 'epsilon': 2.1601562776693364e-09,
'n_iter_no_change': 86, 'max_fun': 25914}

/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(

{'num_layers': 1, 'nn_fst_layer': 41, 'nn_snd_layer': 90, 'activation': 'relu',
'solver': 'lbfgs', 'alpha': 0.0044096333800824495, 'batch_size': 99,
'learning_rate': 'adaptive', 'learning_rate_init': 5.379003292906596e-06,
'power_t': 3.2410609469010383e-06, 'max_iter': 509, 'tol':
1.017304486869379e-06, 'momentum': 0.3187248868725959, 'nesterovs_momentum':
True, 'validation_fraction': 0.4473148169648237, 'beta_1': 0.12177818002046524,
'beta_2': 0.09745834287992643, 'epsilon': 4.836939060008291e-08,
'n_iter_no_change': 58, 'max_fun': 14906}

/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:541:
ConvergenceWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
  self.n_iter_ = _check_optimize_result("lbfgs", opt_res, self.max_iter)
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:541:
ConvergenceWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
```

```
    https://scikit-learn.org/stable/modules/preprocessing.html
  self.n_iter_ = _check_optimize_result("lbfgs", opt_res, self.max_iter)
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:541:
ConvergenceWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
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/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
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  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:541:
ConvergenceWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
  self.n_iter_ = _check_optimize_result("lbfgs", opt_res, self.max_iter)
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(

{'num_layers': 2, 'nn_fst_layer': 10, 'nn_snd_layer': 30, 'activation': 'relu',
'solver': 'lbfgs', 'alpha': 0.000996742104221921, 'batch_size': 15,
'learning_rate': 'invscaling', 'learning_rate_init': 0.00023336629070836956,
'power_t': 0.07507807236904018, 'max_iter': 505, 'tol': 0.0013270222132387927,
'momentum': 0.8500984888213448, 'nesterovs_momentum': False,
'validation_fraction': 0.257325629516244, 'beta_1': 0.6173873090778284,
'beta_2': 0.6773136512003485, 'epsilon': 1.3724146802368132e-08,
'n_iter_no_change': 78, 'max_fun': 4485}

/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
```

```
{'num_layers': 1, 'nn_fst_layer': 33, 'nn_snd_layer': 89, 'activation':
'logistic', 'solver': 'adam', 'alpha': 7.458019564994481e-06, 'batch_size': 19,
'learning_rate': 'adaptive', 'learning_rate_init': 9.89965839132273e-06,
'power_t': 0.0004304916761111288, 'max_iter': 707, 'tol': 0.0001247664806898043,
'momentum': 0.23159228280166036, 'nesterovs_momentum': True,
'validation_fraction': 0.49768121607621457, 'beta_1': 0.35357735173497806,
'beta_2': 0.6794967817866192, 'epsilon': 1.4309567952580232e-09,
'n_iter_no_change': 97, 'max_fun': 4291}
```

```
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (707) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (707) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (707) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
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  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (707) reached and
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  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
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  warnings.warn(
/usr/local/lib/python3.10/dist-
```

```
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (707) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(

{'num_layers': 2, 'nn_fst_layer': 16, 'nn_snd_layer': 13, 'activation':
'logistic', 'solver': 'sgd', 'alpha': 5.545763146862674e-05, 'batch_size': 68,
'learning_rate': 'invscaling', 'learning_rate_init': 3.676970302090313e-06,
'power_t': 1.1607495138902334e-06, 'max_iter': 725, 'tol':
0.00014472418699322645, 'momentum': 0.8874147458482402, 'nesterovs_momentum':
True, 'validation_fraction': 0.07926162074089388, 'beta_1': 0.8934548534306599,
'beta_2': 0.05810741964506274, 'epsilon': 2.308357931036799e-07,
'n_iter_no_change': 51, 'max_fun': 5460}

/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(

{'num_layers': 2, 'nn_fst_layer': 19, 'nn_snd_layer': 7, 'activation': 'tanh',
'solver': 'lbfgs', 'alpha': 0.0005765194522123815, 'batch_size': 72,
'learning_rate': 'constant', 'learning_rate_init': 0.0005014413388997113,
'power_t': 7.263870919452462e-05, 'max_iter': 789, 'tol':
0.00022244885163883788, 'momentum': 0.8915680892494638, 'nesterovs_momentum':
False, 'validation_fraction': 0.4879105001197272, 'beta_1': 0.4549257027731678,
'beta_2': 0.12941387810821495, 'epsilon': 1.7448048133662824e-09,
'n_iter_no_change': 80, 'max_fun': 1507}

/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
```

```
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(

{'num_layers': 1, 'nn_fst_layer': 2, 'nn_snd_layer': 2, 'activation': 'relu',
'solver': 'lbfgs', 'alpha': 0.00292840177543063, 'batch_size': 43,
'learning_rate': 'adaptive', 'learning_rate_init': 0.0005254007670062652,
'power_t': 0.001136995280119362, 'max_iter': 890, 'tol': 3.1149483418581985e-06,
'momentum': 0.5995182396372464, 'nesterovs_momentum': True,
'validation_fraction': 0.31821502547120073, 'beta_1': 0.7132455388480792,
'beta_2': 0.6772308328005707, 'epsilon': 3.918791111150137e-08,
'n_iter_no_change': 28, 'max_fun': 2090}

/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(

{'num_layers': 2, 'nn_fst_layer': 11, 'nn_snd_layer': 8, 'activation': 'relu',
'solver': 'lbfgs', 'alpha': 5.635853984553504e-05, 'batch_size': 95,
'learning_rate': 'invscaling', 'learning_rate_init': 0.00010112860973671964,
'power_t': 2.0966771013803213e-05, 'max_iter': 878, 'tol':
0.00025330502576307245, 'momentum': 0.6121871867174342, 'nesterovs_momentum':
False, 'validation_fraction': 0.14689692171979446, 'beta_1': 0.4615332012395533,
'beta_2': 0.8195181502892838, 'epsilon': 7.925421173954463e-07,
'n_iter_no_change': 79, 'max_fun': 1648}

/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
```

```
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
```

```
{'num_layers': 2, 'nn_fst_layer': 80, 'nn_snd_layer': 1, 'activation':
'logistic', 'solver': 'lbfgs', 'alpha': 0.0045231688267480166, 'batch_size': 84,
'learning_rate': 'adaptive', 'learning_rate_init': 2.791755863359452e-05,
'power_t': 0.029242241926283965, 'max_iter': 574, 'tol': 2.0997494624682364e-05,
'momentum': 0.7407440234932069, 'nesterovs_momentum': True,
'validation_fraction': 0.043571738715074027, 'beta_1': 0.592182249474592,
'beta_2': 0.9951146763395033, 'epsilon': 2.383400439977357e-07,
'n_iter_no_change': 99, 'max_fun': 25545}
```

```
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:541:
ConvergenceWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
  self.n_iter_ = _check_optimize_result("lbfgs", opt_res, self.max_iter)
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:541:
ConvergenceWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
  self.n_iter_ = _check_optimize_result("lbfgs", opt_res, self.max_iter)
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:541:
ConvergenceWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
  self.n_iter_ = _check_optimize_result("lbfgs", opt_res, self.max_iter)
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
```

```
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:541:
ConvergenceWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
  self.n_iter_ = _check_optimize_result("lbfgs", opt_res, self.max_iter)
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:541:
ConvergenceWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
  self.n_iter_ = _check_optimize_result("lbfgs", opt_res, self.max_iter)
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
```

```
{'num_layers': 1, 'nn_fst_layer': 10, 'nn_snd_layer': 4, 'activation': 'relu',
'solver': 'sgd', 'alpha': 1.291642687640286e-06, 'batch_size': 95,
'learning_rate': 'adaptive', 'learning_rate_init': 2.5200088484573617e-06,
'power_t': 0.00038774604727514507, 'max_iter': 824, 'tol':
7.605543637878938e-05, 'momentum': 0.5424444498263884, 'nesterovs_momentum':
False, 'validation_fraction': 0.46733716357885113, 'beta_1': 0.8274314541693221,
'beta_2': 0.4309808020990742, 'epsilon': 2.1533349803221686e-10,
'n_iter_no_change': 32, 'max_fun': 24786}
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
```

```
{'num_layers': 2, 'nn_fst_layer': 79, 'nn_snd_layer': 27, 'activation':
'logistic', 'solver': 'sgd', 'alpha': 4.267421685158142e-06, 'batch_size': 62,
'learning_rate': 'constant', 'learning_rate_init': 0.000867169063266772,
'power_t': 0.028816661479236328, 'max_iter': 859, 'tol': 1.046539494914129e-06,
'momentum': 0.44912553871441674, 'nesterovs_momentum': True,
'validation_fraction': 0.1635104953781038, 'beta_1': 0.870695819866112,
'beta_2': 0.4454586298471939, 'epsilon': 3.708823740587275e-08,
'n_iter_no_change': 74, 'max_fun': 4374}
```

```
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (859) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (859) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (859) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (859) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
  warnings.warn(
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:686:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (859) reached and
the optimization hasn't converged yet.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:432: UserWarning: X has
feature names, but MLPClassifier was fitted without feature names
```

```
  warnings.warn(
```

[28]:
```
result.x
```

[28]:
```
[2,
 42,
 71,
 'logistic',
 'lbfgs',
 0.0016797304312511862,
 52,
 'invscaling',
 0.0005208012653703742,
 1.3499894600491117e-06,
 801,
 2.437733590381186e-06,
 0.805771513687481,
 False,
 0.4688985210894677,
 0.2334915810999844,
 0.9522742442962157,
 3.351998611086149e-07,
 53,
 23205]
```

[29]:
```
if(result.x[0] == 1):
  hidden_layer=(result.x[1],)
if(result.x[0] == 2):
  hidden_layer=(result.x[1],result.x[2])

losses = []
for i in range(10):
  mlp_classifier = MLPClassifier(hidden_layer_sizes=hidden_layer,␣
 ↪activation=result.x[3], solver=result.x[4], alpha=result.x[5],
                                 batch_size=result.x[6], learning_rate=result.
 ↪x[7], learning_rate_init=result.x[8], power_t=result.x[9],
                                 max_iter=result.x[10], shuffle=True,␣
 ↪random_state=None, tol=result.x[11], verbose=False,
                                 warm_start=False, momentum=result.x[12],␣
 ↪nesterovs_momentum=result.x[13], early_stopping=False,
                                 validation_fraction=result.x[14], beta_1=result.
 ↪x[15], beta_2=result.x[16], epsilon=result.x[17],
                                 n_iter_no_change=result.x[18], max_fun=result.
 ↪x[19])

  mlp_classifier.fit(x_train, y_train)
  losses.append(mlp_classifier.loss_)
```

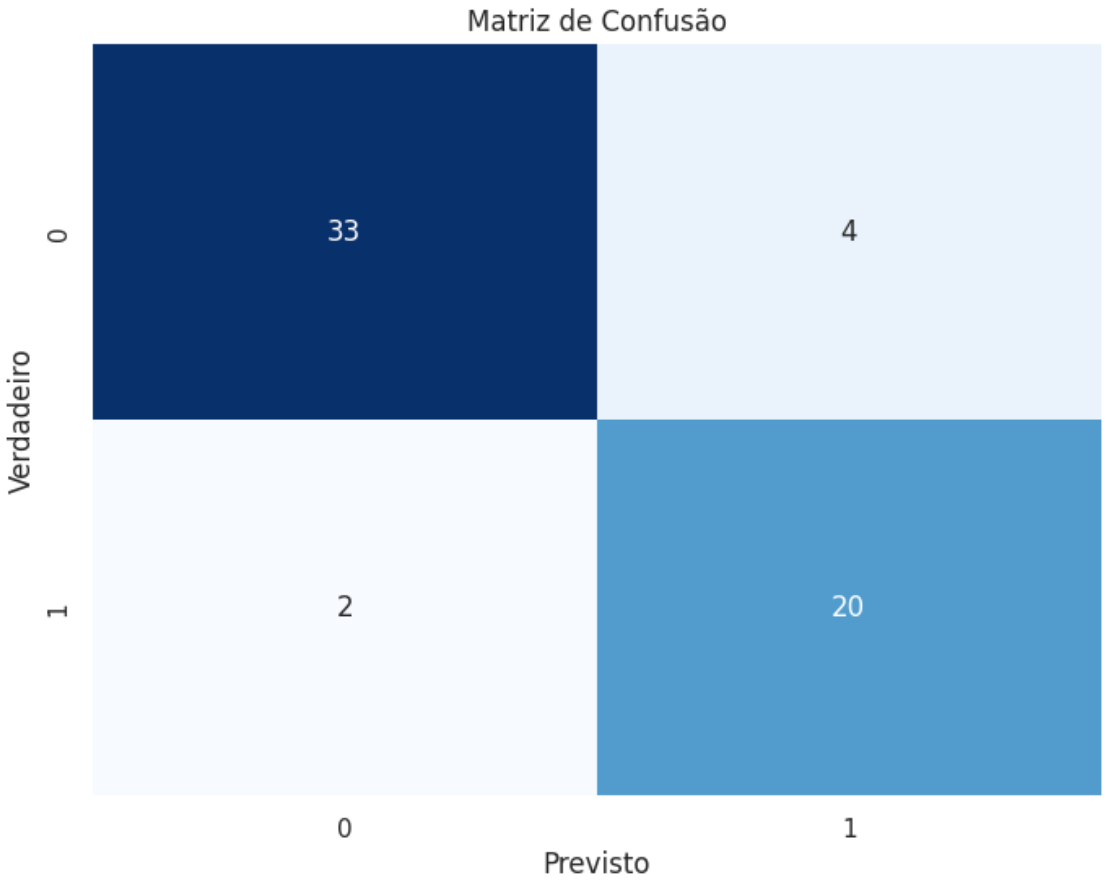
```python
print("Loss do MLP Classifier:", np.mean(losses))
```

```
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:541:
ConvergenceWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
  self.n_iter_ = _check_optimize_result("lbfgs", opt_res, self.max_iter)
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:541:
ConvergenceWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
  self.n_iter_ = _check_optimize_result("lbfgs", opt_res, self.max_iter)
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:541:
ConvergenceWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
  self.n_iter_ = _check_optimize_result("lbfgs", opt_res, self.max_iter)
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:541:
ConvergenceWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
  self.n_iter_ = _check_optimize_result("lbfgs", opt_res, self.max_iter)
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:541:
ConvergenceWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.
```

```
Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
  self.n_iter_ = _check_optimize_result("lbfgs", opt_res, self.max_iter)
/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:541:
ConvergenceWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
  self.n_iter_ = _check_optimize_result("lbfgs", opt_res, self.max_iter)

Loss do MLP Classifier: 0.0013173242808889325

/usr/local/lib/python3.10/dist-
packages/sklearn/neural_network/_multilayer_perceptron.py:541:
ConvergenceWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
  self.n_iter_ = _check_optimize_result("lbfgs", opt_res, self.max_iter)
```

[30]:
```python
y_pred = mlp_classifier.predict(x_test)

accuracy = accuracy_score(y_test, y_pred)
print(f"Acurácia do modelo: {accuracy:.2f}")
print("Classification Report")
print(classification_report(y_test, y_pred))

confusion = confusion_matrix(y_test, y_pred)
plt.figure(figsize=(8, 6))
sns.heatmap(confusion, annot=True, fmt="d", cmap="Blues", cbar=False)
plt.xlabel('Previsto')
plt.ylabel('Verdadeiro')
plt.title('Matriz de Confusão')
plt.show()
```

```
Acurácia do modelo: 0.90
Classification Report
              precision    recall  f1-score   support

           0       0.94      0.89      0.92        37
           1       0.83      0.91      0.87        22

    accuracy                           0.90        59
   macro avg       0.89      0.90      0.89        59
weighted avg       0.90      0.90      0.90        59
```



##Salvar como PDF

[ ]:
```
!apt-get install texlive texlive-xetex texlive-latex-extra pandoc
!pip install pypandoc
```

```
Reading package lists… Done
Building dependency tree… Done
Reading state information… Done
pandoc is already the newest version (2.9.2.1-3ubuntu2).
pandoc set to manually installed.
The following additional packages will be installed:
  dvisvgm fonts-droid-fallback fonts-lato fonts-lmodern fonts-noto-mono
  fonts-texgyre fonts-urw-base35 libapache-pom-java libcommons-logging-java
  libcommons-parent-java libfontbox-java libfontenc1 libgs9 libgs9-common
  libidn12 libijs-0.35 libjbig2dec0 libkpathsea6 libpdfbox-java libptexenc1
  libruby3.0 libsynctex2 libteckit0 libtexlua53 libtexluajit2 libwoff1
  libzzip-0-13 lmodern poppler-data preview-latex-style rake ruby
  ruby-net-telnet ruby-rubygems ruby-webrick ruby-xmlrpc ruby3.0
  rubygems-integration t1utils teckit tex-common tex-gyre texlive-base
  texlive-binaries texlive-fonts-recommended texlive-latex-base
```

```
  texlive-latex-recommended texlive-pictures texlive-plain-generic tipa
  xfonts-encodings xfonts-utils
Suggested packages:
  fonts-noto fonts-freefont-otf | fonts-freefont-ttf libavalon-framework-java
  libcommons-logging-java-doc libexcalibur-logkit-java liblog4j1.2-java
  poppler-utils ghostscript fonts-japanese-mincho | fonts-ipafont-mincho
  fonts-japanese-gothic | fonts-ipafont-gothic fonts-arphic-ukai
  fonts-arphic-uming fonts-nanum ri ruby-dev bundler debhelper gv
  | postscript-viewer perl-tk xpdf | pdf-viewer xzdec
  texlive-fonts-recommended-doc texlive-latex-base-doc python3-pygments
  icc-profiles libfile-which-perl libspreadsheet-parseexcel-perl
  texlive-latex-extra-doc texlive-latex-recommended-doc texlive-luatex
  texlive-pstricks dot2tex prerex texlive-pictures-doc vprerex
  default-jre-headless tipa-doc
The following NEW packages will be installed:
  dvisvgm fonts-droid-fallback fonts-lato fonts-lmodern fonts-noto-mono
  fonts-texgyre fonts-urw-base35 libapache-pom-java libcommons-logging-java
  libcommons-parent-java libfontbox-java libfontenc1 libgs9 libgs9-common
  libidn12 libijs-0.35 libjbig2dec0 libkpathsea6 libpdfbox-java libptexenc1
  libruby3.0 libsynctex2 libteckit0 libtexlua53 libtexluajit2 libwoff1
  libzzip-0-13 lmodern poppler-data preview-latex-style rake ruby
  ruby-net-telnet ruby-rubygems ruby-webrick ruby-xmlrpc ruby3.0
  rubygems-integration t1utils teckit tex-common tex-gyre texlive texlive-base
  texlive-binaries texlive-fonts-recommended texlive-latex-base
  texlive-latex-extra texlive-latex-recommended texlive-pictures
  texlive-plain-generic texlive-xetex tipa xfonts-encodings xfonts-utils
0 upgraded, 55 newly installed, 0 to remove and 16 not upgraded.
Need to get 182 MB of archives.
After this operation, 572 MB of additional disk space will be used.
Get:1 http://archive.ubuntu.com/ubuntu jammy/main amd64 fonts-droid-fallback all
1:6.0.1r16-1.1build1 [1,805 kB]
Get:2 http://archive.ubuntu.com/ubuntu jammy/main amd64 fonts-lato all 2.0-2.1
[2,696 kB]
Get:3 http://archive.ubuntu.com/ubuntu jammy/main amd64 poppler-data all
0.4.11-1 [2,171 kB]
Get:4 http://archive.ubuntu.com/ubuntu jammy/universe amd64 tex-common all 6.17
[33.7 kB]
Get:5 http://archive.ubuntu.com/ubuntu jammy/main amd64 fonts-urw-base35 all
20200910-1 [6,367 kB]
Get:6 http://archive.ubuntu.com/ubuntu jammy-updates/main amd64 libgs9-common
all 9.55.0~dfsg1-0ubuntu5.4 [752 kB]
Get:7 http://archive.ubuntu.com/ubuntu jammy-updates/main amd64 libidn12 amd64
1.38-4ubuntu1 [60.0 kB]
Get:8 http://archive.ubuntu.com/ubuntu jammy/main amd64 libijs-0.35 amd64
0.35-15build2 [16.5 kB]
Get:9 http://archive.ubuntu.com/ubuntu jammy/main amd64 libjbig2dec0 amd64
0.19-3build2 [64.7 kB]
Get:10 http://archive.ubuntu.com/ubuntu jammy-updates/main amd64 libgs9 amd64
```

```
9.55.0~dfsg1-0ubuntu5.4 [5,032 kB]
Get:11 http://archive.ubuntu.com/ubuntu jammy-updates/main amd64 libkpathsea6
amd64 2021.20210626.59705-1ubuntu0.1 [60.3 kB]
Get:12 http://archive.ubuntu.com/ubuntu jammy/main amd64 libwoff1 amd64
1.0.2-1build4 [45.2 kB]
Get:13 http://archive.ubuntu.com/ubuntu jammy/universe amd64 dvisvgm amd64
2.13.1-1 [1,221 kB]
Get:14 http://archive.ubuntu.com/ubuntu jammy/universe amd64 fonts-lmodern all
2.004.5-6.1 [4,532 kB]
Get:15 http://archive.ubuntu.com/ubuntu jammy/main amd64 fonts-noto-mono all
20201225-1build1 [397 kB]
Get:16 http://archive.ubuntu.com/ubuntu jammy/universe amd64 fonts-texgyre all
20180621-3.1 [10.2 MB]
Get:17 http://archive.ubuntu.com/ubuntu jammy/universe amd64 libapache-pom-java
all 18-1 [4,720 B]
Get:18 http://archive.ubuntu.com/ubuntu jammy/universe amd64 libcommons-parent-
java all 43-1 [10.8 kB]
Get:19 http://archive.ubuntu.com/ubuntu jammy/universe amd64 libcommons-logging-
java all 1.2-2 [60.3 kB]
Get:20 http://archive.ubuntu.com/ubuntu jammy/main amd64 libfontenc1 amd64
1:1.1.4-1build3 [14.7 kB]
Get:21 http://archive.ubuntu.com/ubuntu jammy-updates/main amd64 libptexenc1
amd64 2021.20210626.59705-1ubuntu0.1 [39.1 kB]
Get:22 http://archive.ubuntu.com/ubuntu jammy/main amd64 rubygems-integration
all 1.18 [5,336 B]
Get:23 http://archive.ubuntu.com/ubuntu jammy-updates/main amd64 ruby3.0 amd64
3.0.2-7ubuntu2.4 [50.1 kB]
Get:24 http://archive.ubuntu.com/ubuntu jammy/main amd64 ruby-rubygems all
3.3.5-2 [228 kB]
Get:25 http://archive.ubuntu.com/ubuntu jammy/main amd64 ruby amd64 1:3.0~exp1
[5,100 B]
Get:26 http://archive.ubuntu.com/ubuntu jammy/main amd64 rake all 13.0.6-2 [61.7
kB]
Get:27 http://archive.ubuntu.com/ubuntu jammy/main amd64 ruby-net-telnet all
0.1.1-2 [12.6 kB]
Get:28 http://archive.ubuntu.com/ubuntu jammy/universe amd64 ruby-webrick all
1.7.0-3 [51.8 kB]
Get:29 http://archive.ubuntu.com/ubuntu jammy-updates/main amd64 ruby-xmlrpc all
0.3.2-1ubuntu0.1 [24.9 kB]
Get:30 http://archive.ubuntu.com/ubuntu jammy-updates/main amd64 libruby3.0
amd64 3.0.2-7ubuntu2.4 [5,113 kB]
Get:31 http://archive.ubuntu.com/ubuntu jammy-updates/main amd64 libsynctex2
amd64 2021.20210626.59705-1ubuntu0.1 [55.5 kB]
Get:32 http://archive.ubuntu.com/ubuntu jammy/universe amd64 libteckit0 amd64
2.5.11+ds1-1 [421 kB]
Get:33 http://archive.ubuntu.com/ubuntu jammy-updates/main amd64 libtexlua53
amd64 2021.20210626.59705-1ubuntu0.1 [120 kB]
Get:34 http://archive.ubuntu.com/ubuntu jammy-updates/main amd64 libtexluajit2
```

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amd64 2021.20210626.59705-1ubuntu0.1 [267 kB]
Get:35 http://archive.ubuntu.com/ubuntu jammy/universe amd64 libzzip-0-13 amd64
0.13.72+dfsg.1-1.1 [27.0 kB]
Get:36 http://archive.ubuntu.com/ubuntu jammy/main amd64 xfonts-encodings all
1:1.0.5-0ubuntu2 [578 kB]
Get:37 http://archive.ubuntu.com/ubuntu jammy/main amd64 xfonts-utils amd64
1:7.7+6build2 [94.6 kB]
Get:38 http://archive.ubuntu.com/ubuntu jammy/universe amd64 lmodern all
2.004.5-6.1 [9,471 kB]
Get:39 http://archive.ubuntu.com/ubuntu jammy/universe amd64 preview-latex-style
all 12.2-1ubuntu1 [185 kB]
Get:40 http://archive.ubuntu.com/ubuntu jammy/main amd64 t1utils amd64
1.41-4build2 [61.3 kB]
Get:41 http://archive.ubuntu.com/ubuntu jammy/universe amd64 teckit amd64
2.5.11+ds1-1 [699 kB]
Get:42 http://archive.ubuntu.com/ubuntu jammy/universe amd64 tex-gyre all
20180621-3.1 [6,209 kB]
Get:43 http://archive.ubuntu.com/ubuntu jammy-updates/universe amd64 texlive-
binaries amd64 2021.20210626.59705-1ubuntu0.1 [9,848 kB]
Get:44 http://archive.ubuntu.com/ubuntu jammy/universe amd64 texlive-base all
2021.20220204-1 [21.0 MB]
Get:45 http://archive.ubuntu.com/ubuntu jammy/universe amd64 texlive-fonts-
recommended all 2021.20220204-1 [4,972 kB]
Get:46 http://archive.ubuntu.com/ubuntu jammy/universe amd64 texlive-latex-base
all 2021.20220204-1 [1,128 kB]
Get:47 http://archive.ubuntu.com/ubuntu jammy/universe amd64 texlive-latex-
recommended all 2021.20220204-1 [14.4 MB]
Get:48 http://archive.ubuntu.com/ubuntu jammy/universe amd64 texlive all
2021.20220204-1 [14.3 kB]
Get:49 http://archive.ubuntu.com/ubuntu jammy/universe amd64 libfontbox-java all
1:1.8.16-2 [207 kB]
Get:50 http://archive.ubuntu.com/ubuntu jammy/universe amd64 libpdfbox-java all
1:1.8.16-2 [5,199 kB]
Get:51 http://archive.ubuntu.com/ubuntu jammy/universe amd64 texlive-pictures
all 2021.20220204-1 [8,720 kB]
Get:52 http://archive.ubuntu.com/ubuntu jammy/universe amd64 texlive-latex-extra
all 2021.20220204-1 [13.9 MB]
Get:53 http://archive.ubuntu.com/ubuntu jammy/universe amd64 texlive-plain-
generic all 2021.20220204-1 [27.5 MB]
Get:54 http://archive.ubuntu.com/ubuntu jammy/universe amd64 tipa all 2:1.3-21
[2,967 kB]
Get:55 http://archive.ubuntu.com/ubuntu jammy/universe amd64 texlive-xetex all
2021.20220204-1 [12.4 MB]
Fetched 182 MB in 20s (8,870 kB/s)
Extracting templates from packages: 100%
Preconfiguring packages …
Selecting previously unselected package fonts-droid-fallback.
(Reading database … 120893 files and directories currently installed.)
```

```
Preparing to unpack …/00-fonts-droid-fallback_1%3a6.0.1r16-1.1build1_all.deb
…
Unpacking fonts-droid-fallback (1:6.0.1r16-1.1build1) …
Selecting previously unselected package fonts-lato.
Preparing to unpack …/01-fonts-lato_2.0-2.1_all.deb …
Unpacking fonts-lato (2.0-2.1) …
Selecting previously unselected package poppler-data.
Preparing to unpack …/02-poppler-data_0.4.11-1_all.deb …
Unpacking poppler-data (0.4.11-1) …
Selecting previously unselected package tex-common.
Preparing to unpack …/03-tex-common_6.17_all.deb …
Unpacking tex-common (6.17) …
Selecting previously unselected package fonts-urw-base35.
Preparing to unpack …/04-fonts-urw-base35_20200910-1_all.deb …
Unpacking fonts-urw-base35 (20200910-1) …
Selecting previously unselected package libgs9-common.
Preparing to unpack …/05-libgs9-common_9.55.0~dfsg1-0ubuntu5.4_all.deb …
Unpacking libgs9-common (9.55.0~dfsg1-0ubuntu5.4) …
Selecting previously unselected package libidn12:amd64.
Preparing to unpack …/06-libidn12_1.38-4ubuntu1_amd64.deb …
Unpacking libidn12:amd64 (1.38-4ubuntu1) …
Selecting previously unselected package libijs-0.35:amd64.
Preparing to unpack …/07-libijs-0.35_0.35-15build2_amd64.deb …
Unpacking libijs-0.35:amd64 (0.35-15build2) …
Selecting previously unselected package libjbig2dec0:amd64.
Preparing to unpack …/08-libjbig2dec0_0.19-3build2_amd64.deb …
Unpacking libjbig2dec0:amd64 (0.19-3build2) …
Selecting previously unselected package libgs9:amd64.
Preparing to unpack …/09-libgs9_9.55.0~dfsg1-0ubuntu5.4_amd64.deb …
Unpacking libgs9:amd64 (9.55.0~dfsg1-0ubuntu5.4) …
Selecting previously unselected package libkpathsea6:amd64.
Preparing to unpack …/10-libkpathsea6_2021.20210626.59705-1ubuntu0.1_amd64.deb
…
Unpacking libkpathsea6:amd64 (2021.20210626.59705-1ubuntu0.1) …
Selecting previously unselected package libwoff1:amd64.
Preparing to unpack …/11-libwoff1_1.0.2-1build4_amd64.deb …
Unpacking libwoff1:amd64 (1.0.2-1build4) …
Selecting previously unselected package dvisvgm.
Preparing to unpack …/12-dvisvgm_2.13.1-1_amd64.deb …
Unpacking dvisvgm (2.13.1-1) …
Selecting previously unselected package fonts-lmodern.
Preparing to unpack …/13-fonts-lmodern_2.004.5-6.1_all.deb …
Unpacking fonts-lmodern (2.004.5-6.1) …
Selecting previously unselected package fonts-noto-mono.
Preparing to unpack …/14-fonts-noto-mono_20201225-1build1_all.deb …
Unpacking fonts-noto-mono (20201225-1build1) …
Selecting previously unselected package fonts-texgyre.
Preparing to unpack …/15-fonts-texgyre_20180621-3.1_all.deb …
```

```
Unpacking fonts-texgyre (20180621-3.1) …
Selecting previously unselected package libapache-pom-java.
Preparing to unpack …/16-libapache-pom-java_18-1_all.deb …
Unpacking libapache-pom-java (18-1) …
Selecting previously unselected package libcommons-parent-java.
Preparing to unpack …/17-libcommons-parent-java_43-1_all.deb …
Unpacking libcommons-parent-java (43-1) …
Selecting previously unselected package libcommons-logging-java.
Preparing to unpack …/18-libcommons-logging-java_1.2-2_all.deb …
Unpacking libcommons-logging-java (1.2-2) …
Selecting previously unselected package libfontenc1:amd64.
Preparing to unpack …/19-libfontenc1_1%3a1.1.4-1build3_amd64.deb …
Unpacking libfontenc1:amd64 (1:1.1.4-1build3) …
Selecting previously unselected package libptexenc1:amd64.
Preparing to unpack …/20-libptexenc1_2021.20210626.59705-1ubuntu0.1_amd64.deb
…
Unpacking libptexenc1:amd64 (2021.20210626.59705-1ubuntu0.1) …
Selecting previously unselected package rubygems-integration.
Preparing to unpack …/21-rubygems-integration_1.18_all.deb …
Unpacking rubygems-integration (1.18) …
Selecting previously unselected package ruby3.0.
Preparing to unpack …/22-ruby3.0_3.0.2-7ubuntu2.4_amd64.deb …
Unpacking ruby3.0 (3.0.2-7ubuntu2.4) …
Selecting previously unselected package ruby-rubygems.
Preparing to unpack …/23-ruby-rubygems_3.3.5-2_all.deb …
Unpacking ruby-rubygems (3.3.5-2) …
Selecting previously unselected package ruby.
Preparing to unpack …/24-ruby_1%3a3.0~exp1_amd64.deb …
Unpacking ruby (1:3.0~exp1) …
Selecting previously unselected package rake.
Preparing to unpack …/25-rake_13.0.6-2_all.deb …
Unpacking rake (13.0.6-2) …
Selecting previously unselected package ruby-net-telnet.
Preparing to unpack …/26-ruby-net-telnet_0.1.1-2_all.deb …
Unpacking ruby-net-telnet (0.1.1-2) …
Selecting previously unselected package ruby-webrick.
Preparing to unpack …/27-ruby-webrick_1.7.0-3_all.deb …
Unpacking ruby-webrick (1.7.0-3) …
Selecting previously unselected package ruby-xmlrpc.
Preparing to unpack …/28-ruby-xmlrpc_0.3.2-1ubuntu0.1_all.deb …
Unpacking ruby-xmlrpc (0.3.2-1ubuntu0.1) …
Selecting previously unselected package libruby3.0:amd64.
Preparing to unpack …/29-libruby3.0_3.0.2-7ubuntu2.4_amd64.deb …
Unpacking libruby3.0:amd64 (3.0.2-7ubuntu2.4) …
Selecting previously unselected package libsynctex2:amd64.
Preparing to unpack …/30-libsynctex2_2021.20210626.59705-1ubuntu0.1_amd64.deb
…
Unpacking libsynctex2:amd64 (2021.20210626.59705-1ubuntu0.1) …
```

```
Selecting previously unselected package libteckit0:amd64.
Preparing to unpack …/31-libteckit0_2.5.11+ds1-1_amd64.deb …
Unpacking libteckit0:amd64 (2.5.11+ds1-1) …
Selecting previously unselected package libtexlua53:amd64.
Preparing to unpack …/32-libtexlua53_2021.20210626.59705-1ubuntu0.1_amd64.deb
…
Unpacking libtexlua53:amd64 (2021.20210626.59705-1ubuntu0.1) …
Selecting previously unselected package libtexluajit2:amd64.
Preparing to unpack
…/33-libtexluajit2_2021.20210626.59705-1ubuntu0.1_amd64.deb …
Unpacking libtexluajit2:amd64 (2021.20210626.59705-1ubuntu0.1) …
Selecting previously unselected package libzzip-0-13:amd64.
Preparing to unpack …/34-libzzip-0-13_0.13.72+dfsg.1-1.1_amd64.deb …
Unpacking libzzip-0-13:amd64 (0.13.72+dfsg.1-1.1) …
Selecting previously unselected package xfonts-encodings.
Preparing to unpack …/35-xfonts-encodings_1%3a1.0.5-0ubuntu2_all.deb …
Unpacking xfonts-encodings (1:1.0.5-0ubuntu2) …
Selecting previously unselected package xfonts-utils.
Preparing to unpack …/36-xfonts-utils_1%3a7.7+6build2_amd64.deb …
Unpacking xfonts-utils (1:7.7+6build2) …
Selecting previously unselected package lmodern.
Preparing to unpack …/37-lmodern_2.004.5-6.1_all.deb …
Unpacking lmodern (2.004.5-6.1) …
Selecting previously unselected package preview-latex-style.
Preparing to unpack …/38-preview-latex-style_12.2-1ubuntu1_all.deb …
Unpacking preview-latex-style (12.2-1ubuntu1) …
Selecting previously unselected package t1utils.
Preparing to unpack …/39-t1utils_1.41-4build2_amd64.deb …
Unpacking t1utils (1.41-4build2) …
Selecting previously unselected package teckit.
Preparing to unpack …/40-teckit_2.5.11+ds1-1_amd64.deb …
Unpacking teckit (2.5.11+ds1-1) …
Selecting previously unselected package tex-gyre.
Preparing to unpack …/41-tex-gyre_20180621-3.1_all.deb …
Unpacking tex-gyre (20180621-3.1) …
Selecting previously unselected package texlive-binaries.
Preparing to unpack …/42-texlive-
binaries_2021.20210626.59705-1ubuntu0.1_amd64.deb …
Unpacking texlive-binaries (2021.20210626.59705-1ubuntu0.1) …
Selecting previously unselected package texlive-base.
Preparing to unpack …/43-texlive-base_2021.20220204-1_all.deb …
Unpacking texlive-base (2021.20220204-1) …
Selecting previously unselected package texlive-fonts-recommended.
Preparing to unpack …/44-texlive-fonts-recommended_2021.20220204-1_all.deb …
Unpacking texlive-fonts-recommended (2021.20220204-1) …
Selecting previously unselected package texlive-latex-base.
Preparing to unpack …/45-texlive-latex-base_2021.20220204-1_all.deb …
Unpacking texlive-latex-base (2021.20220204-1) …
```

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Selecting previously unselected package texlive-latex-recommended.
Preparing to unpack …/46-texlive-latex-recommended_2021.20220204-1_all.deb …
Unpacking texlive-latex-recommended (2021.20220204-1) …
Selecting previously unselected package texlive.
Preparing to unpack …/47-texlive_2021.20220204-1_all.deb …
Unpacking texlive (2021.20220204-1) …
Selecting previously unselected package libfontbox-java.
Preparing to unpack …/48-libfontbox-java_1%3a1.8.16-2_all.deb …
Unpacking libfontbox-java (1:1.8.16-2) …
Selecting previously unselected package libpdfbox-java.
Preparing to unpack …/49-libpdfbox-java_1%3a1.8.16-2_all.deb …
Unpacking libpdfbox-java (1:1.8.16-2) …
Selecting previously unselected package texlive-pictures.
Preparing to unpack …/50-texlive-pictures_2021.20220204-1_all.deb …
Unpacking texlive-pictures (2021.20220204-1) …
Selecting previously unselected package texlive-latex-extra.
Preparing to unpack …/51-texlive-latex-extra_2021.20220204-1_all.deb …
Unpacking texlive-latex-extra (2021.20220204-1) …
Selecting previously unselected package texlive-plain-generic.
Preparing to unpack …/52-texlive-plain-generic_2021.20220204-1_all.deb …
Unpacking texlive-plain-generic (2021.20220204-1) …
Selecting previously unselected package tipa.
Preparing to unpack …/53-tipa_2%3a1.3-21_all.deb …
Unpacking tipa (2:1.3-21) …
Selecting previously unselected package texlive-xetex.
Preparing to unpack …/54-texlive-xetex_2021.20220204-1_all.deb …
Unpacking texlive-xetex (2021.20220204-1) …
Setting up fonts-lato (2.0-2.1) …
Setting up fonts-noto-mono (20201225-1build1) …
Setting up libwoff1:amd64 (1.0.2-1build4) …
Setting up libtexlua53:amd64 (2021.20210626.59705-1ubuntu0.1) …
Setting up libijs-0.35:amd64 (0.35-15build2) …
Setting up libtexluajit2:amd64 (2021.20210626.59705-1ubuntu0.1) …
Setting up libfontbox-java (1:1.8.16-2) …
Setting up rubygems-integration (1.18) …
Setting up libzzip-0-13:amd64 (0.13.72+dfsg.1-1.1) …
Setting up fonts-urw-base35 (20200910-1) …
Setting up poppler-data (0.4.11-1) …
Setting up tex-common (6.17) …
update-language: texlive-base not installed and configured, doing nothing!
Setting up libfontenc1:amd64 (1:1.1.4-1build3) …
Setting up libjbig2dec0:amd64 (0.19-3build2) …
Setting up libteckit0:amd64 (2.5.11+ds1-1) …
Setting up libapache-pom-java (18-1) …
Setting up ruby-net-telnet (0.1.1-2) …
Setting up xfonts-encodings (1:1.0.5-0ubuntu2) …
Setting up t1utils (1.41-4build2) …
Setting up libidn12:amd64 (1.38-4ubuntu1) …
```

```
Setting up fonts-texgyre (20180621-3.1) …
Setting up libkpathsea6:amd64 (2021.20210626.59705-1ubuntu0.1) …
Setting up ruby-webrick (1.7.0-3) …
Setting up fonts-lmodern (2.004.5-6.1) …
Setting up fonts-droid-fallback (1:6.0.1r16-1.1build1) …
Setting up ruby-xmlrpc (0.3.2-1ubuntu0.1) …
Setting up libsynctex2:amd64 (2021.20210626.59705-1ubuntu0.1) …
Setting up libgs9-common (9.55.0~dfsg1-0ubuntu5.4) …
Setting up teckit (2.5.11+ds1-1) …
Setting up libpdfbox-java (1:1.8.16-2) …
Setting up libgs9:amd64 (9.55.0~dfsg1-0ubuntu5.4) …
Setting up preview-latex-style (12.2-1ubuntu1) …
Setting up libcommons-parent-java (43-1) …
Setting up dvisvgm (2.13.1-1) …
Setting up libcommons-logging-java (1.2-2) …
Setting up xfonts-utils (1:7.7+6build2) …
Setting up libptexenc1:amd64 (2021.20210626.59705-1ubuntu0.1) …
Setting up texlive-binaries (2021.20210626.59705-1ubuntu0.1) …
update-alternatives: using /usr/bin/xdvi-xaw to provide /usr/bin/xdvi.bin
(xdvi.bin) in auto mode
update-alternatives: using /usr/bin/bibtex.original to provide /usr/bin/bibtex
(bibtex) in auto mode
Setting up lmodern (2.004.5-6.1) …
Setting up texlive-base (2021.20220204-1) …
/usr/bin/ucfr
/usr/bin/ucfr
/usr/bin/ucfr
/usr/bin/ucfr
mktexlsr: Updating /var/lib/texmf/ls-R-TEXLIVEDIST…
mktexlsr: Updating /var/lib/texmf/ls-R-TEXMFMAIN…
mktexlsr: Updating /var/lib/texmf/ls-R…
mktexlsr: Done.
tl-paper: setting paper size for dvips to a4:
/var/lib/texmf/dvips/config/config-paper.ps
tl-paper: setting paper size for dvipdfmx to a4:
/var/lib/texmf/dvipdfmx/dvipdfmx-paper.cfg
tl-paper: setting paper size for xdvi to a4: /var/lib/texmf/xdvi/XDvi-paper
tl-paper: setting paper size for pdftex to a4: /var/lib/texmf/tex/generic/tex-
ini-files/pdftexconfig.tex
Setting up tex-gyre (20180621-3.1) …
Setting up texlive-plain-generic (2021.20220204-1) …
Setting up texlive-latex-base (2021.20220204-1) …
Setting up texlive-latex-recommended (2021.20220204-1) …
Setting up texlive-pictures (2021.20220204-1) …
Setting up texlive-fonts-recommended (2021.20220204-1) …
Setting up tipa (2:1.3-21) …
Setting up texlive (2021.20220204-1) …
Setting up texlive-latex-extra (2021.20220204-1) …
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Setting up texlive-xetex (2021.20220204-1) …
Setting up rake (13.0.6-2) …
Setting up libruby3.0:amd64 (3.0.2-7ubuntu2.4) …
Setting up ruby3.0 (3.0.2-7ubuntu2.4) …
Setting up ruby (1:3.0~exp1) …
Setting up ruby-rubygems (3.3.5-2) …
Processing triggers for man-db (2.10.2-1) …
Processing triggers for fontconfig (2.13.1-4.2ubuntu5) …
Processing triggers for libc-bin (2.35-0ubuntu3.1) …
/sbin/ldconfig.real: /usr/local/lib/libtbb.so.12 is not a symbolic link

/sbin/ldconfig.real: /usr/local/lib/libtbbbind.so.3 is not a symbolic link

/sbin/ldconfig.real: /usr/local/lib/libtbbbind_2_0.so.3 is not a symbolic link

/sbin/ldconfig.real: /usr/local/lib/libtbbmalloc_proxy.so.2 is not a symbolic
link

/sbin/ldconfig.real: /usr/local/lib/libtbbbind_2_5.so.3 is not a symbolic link

/sbin/ldconfig.real: /usr/local/lib/libtbbmalloc.so.2 is not a symbolic link
```

[ ]:
```
!jupyter nbconvert --to PDF "/content/drive/MyDrive/Colab Notebooks/
↪Mini-projeto-MLP.ipynb"
```