Test Survey with ML

```
from google.colab import drive
drive.mount('/content/drive')
%cd /content/drive/MyDrive

# List files to make sure we're in the expected directory.
# Your output will look different, showing your own Drive files here.


!ls
```

```
Mounted at /content/drive
/content/drive/MyDrive
 AssEco.gdoc
 Beginning.Python.Visualization.Crafting.Visual.Transformation.Scripts.Shai.Vaingast.2009.pdf
 BookTemplate.pdf
'Colab Notebooks'
 DataVisualization.gdoc
 DataVisualization.pdf
 ISproject_documents
'ITM6304 Quiz and Exercise'
 JBreferences
'Learning Tableau 2019 Tools for Business Intelligence, data prep, and visual analytics.pdf'
'New Headphone Production Survey Complete.csv'
'New Headphone Production Survey Complete.gsheet'
'New Headphone Production Survey for ML.csv'
'New Headphone Production Survey (Responses).gsheet'
 __pycache__
'Report and video adjusting by MATLAB'
 RuleBased_Classification.py
 Survey_MLclassification.py
'Total responses categorized characteristic survey.csv'
```

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt

pd.set_option('display.max_colwidth', None)  # or 199
np.set_printoptions(threshold=np.inf)
pd.set_option('display.max_columns', None)

df = pd.read_csv("New Headphone Production Survey for ML.csv")
```

```
# Algorithms
from sklearn import linear_model
from sklearn.linear_model import LogisticRegression
from sklearn.ensemble import RandomForestClassifier
from sklearn.linear_model import Perceptron
from sklearn.linear_model import SGDClassifier
from sklearn.tree import DecisionTreeClassifier
from sklearn.neighbors import KNeighborsClassifier
from sklearn.svm import SVC, LinearSVC
from sklearn.naive_bayes import GaussianNB
from sklearn.model_selection import train_test_split
from sklearn.metrics import classification_report


# df3 = pd.concat([df]*20, ignore_index=True)

# train_df,test_df = train_test_split(df3, test_size=0.3, random_state=42, shuffle=True)

# X_train = train_df.drop("HpAnswer", axis=1)
# Y_train = train_df["HpAnswer"]
# X_test  = test_df.drop("HpAnswer", axis=1)
# Y_test  = test_df["HpAnswer"]
```

```
#importanct features

df3 = pd.concat([df]*20, ignore_index=True)

train_df,test_df = train_test_split(df3, test_size=0.3, random_state=42, shuffle=True)

X_train = train_df.drop(labels=['Gender','Age','Status','Education','Occupation','HpAnswer'],axis=1)
Y_train = train_df["HpAnswer"]
X_test  = test_df.drop(labels=['Gender','Age','Status','Education','Occupation','HpAnswer'],axis=1)
```

```
Y_test  = test_df["HpAnswer"]

# X_train = train_df.drop("HpAnswer", axis=1)
# Y_train = train_df["HpAnswer"]
# X_test  = test_df.drop("HpAnswer", axis=1)
# Y_test  = test_df["HpAnswer"]

random_forest = RandomForestClassifier(n_estimators=100)
random_forest.fit(X_train, Y_train)
Y_prediction = random_forest.predict(X_test)
Y3           = random_forest.predict_proba(X_test)

random_forest.score(X_train, Y_train)
acc_random_forest = round(random_forest.score(X_train, Y_train) * 100, 2)
#print(classification_report(Y_test, Y_prediction))
#print(acc_random_forest)
#print(Y_prediction,Y3)

importances = pd.DataFrame({'feature':X_train.columns,'importance':np.round(random_forest.feature_importances_,3)})
importances = importances.sort_values('importance',ascending=False).set_index('feature')
#importances_cut = importances.loc[importances['feature']!=['Gender','Age','Status','Education','Occupation']]
#importances_qicks = importances.drop(labels=['Gender','Age','Status','Education','Occupation'],axis=0)
#importances_qicks = importances_qicks.sort_values(by=['importance'])
importances
```

feature	importance
FactorHps	0.136
PriceHps	0.101
ActivityHps	0.092
InnovationHps	0.081
PlaceHps	0.057
InfoHps_PR	0.053
InfoHps_Google	0.046
HealthHps	0.040
PB_disconnect	0.039
InfoHps_Store	0.038
PB_battery	0.037
InfoHps_online	0.036
PB_badsound	0.032
TimeHps	0.030
InfoHps_Social	0.029
PB_audiocut	0.028
NumberHps	0.028
PB_nosound	0.024
PB_toosd	0.023
PB_oneear	0.018
InfoHps_Ads	0.017
PB_unplug	0.014
PB_unfit	0.000

Next steps: Generate code with importances | View recommended plots | New interactive sheet

```
# X_train = train_df[['Gender','Age','Status','Education','Occupation']]
# Y_train = train_df["HpAnswer"]
# X_test = test_df[['Gender','Age','Status','Education','Occupation']]
# Y_test  = test_df["HpAnswer"]
#      colname=['Gender','Age','Status','Education','Occupation','HpAnswer','NumberHps', 'ActivityHps', 'TimeHps','PriceHps','PlaceHps',
#              "PB_nosound","PB_disconnect","PB_badsound","PB_unfit","PB_oneear","PB_toosd","PB_audiocut","PB_battery",\
#              "PB_unplug","InfoHps_online","InfoHps_Social","InfoHps_Google","InfoHps_Store","InfoHps_PR","InfoHps_Ads"]
colname=['ActivityHps','PriceHps','PlaceHps','FactorHps','InnovationHps',\
    "InfoHps_online","InfoHps_Store","InfoHps_PR"]
X_train = train_df[colname]
```

```
Y_train = train_df["HpAnswer"]
X_test  = test_df[colname]
Y_test  = test_df["HpAnswer"]

# X_train = train_df[['FactorHps','PriceHps','ActivityHps','InnovationHps','PlaceHps',"InfoHps_PR","InfoHps_online","InfoHps_Store"]]
# Y_train = train_df["HpAnswer"]
# X_test = test_df[['FactorHps','PriceHps','ActivityHps','InnovationHps','PlaceHps',"InfoHps_PR","InfoHps_online","InfoHps_Store"]]
# Y_test  = test_df["HpAnswer"]

# X_train = train_df.drop(['Gender','Age','Status','Education','Occupation','HpAnswer'], axis=1)
# Y_train = train_df["HpAnswer"]
# X_test  = test_df.drop(['Gender','Age','Status','Education','Occupation','HpAnswer'], axis=1)
# Y_test  = test_df["HpAnswer"]

# X_train = train_df.drop("HpAnswer", axis=1)
# Y_train = train_df["HpAnswer"]
# X_test  = test_df.drop("HpAnswer", axis=1)
# Y_test  = test_df["HpAnswer"]
```

```
random_forest = RandomForestClassifier(n_estimators=100)
random_forest.fit(X_train, Y_train)
Y_prediction = random_forest.predict(X_test)
Y3           = random_forest.predict_proba(X_test)

random_forest.score(X_train, Y_train)
acc_random_forest = round(random_forest.score(X_train, Y_train) * 100, 2)
```

```
sgd = linear_model.SGDClassifier(max_iter=5, tol=None)
sgd.fit(X_train, Y_train)
Y_pred = sgd.predict(X_test)

sgd.score(X_train, Y_train)

acc_sgd = round(sgd.score(X_train, Y_train) * 100, 2)
```

```
logreg = LogisticRegression()
logreg.fit(X_train, Y_train)

Y_pred = logreg.predict(X_test)
Y3     = logreg.predict_proba(X_test)
acc_log = round(logreg.score(X_train, Y_train) * 100, 2)
#print(classification_report(Y_test, Y_pred))
#print(acc_log)
#print(Y_pred,Y3)
```

```
# KNN
knn = KNeighborsClassifier(n_neighbors = 3)
knn.fit(X_train, Y_train)
Y_pred = knn.predict(X_test)
acc_knn = round(knn.score(X_train, Y_train) * 100, 2)
```

```
gaussian = GaussianNB()
gaussian.fit(X_train, Y_train)
Y_pred = gaussian.predict(X_test)
acc_gaussian = round(gaussian.score(X_train, Y_train) * 100, 2)
```

```
perceptron = Perceptron(max_iter=5)
perceptron.fit(X_train, Y_train)

Y_pred = perceptron.predict(X_test)

acc_perceptron = round(perceptron.score(X_train, Y_train) * 100, 2)
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/linear_model/_stochastic_gradient.py:744: ConvergenceWarning: Maximum number of iter
  warnings.warn(
```

```
linear_svc = LinearSVC()
linear_svc.fit(X_train, Y_train)

Y_pred = linear_svc.predict(X_test)

acc_linear_svc = round(linear_svc.score(X_train, Y_train) * 100, 2)
```

```
decision_tree = DecisionTreeClassifier()
decision_tree.fit(X_train, Y_train)
```

```
Y_pred = decision_tree.predict(X_test)
Y3           = decision_tree.predict_proba(X_test)

acc_decision_tree = round(decision_tree.score(X_train, Y_train) * 100, 2)
#print(classification_report(Y_test, Y_pred))
#print(acc_log)
#print(Y_pred,Y3)
```

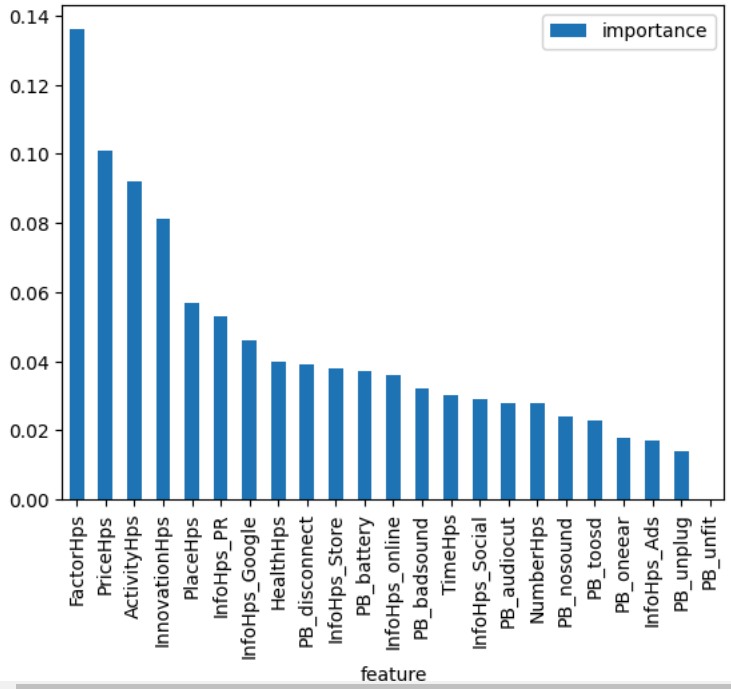
```
results = pd.DataFrame({
    'Model': ['Support Vector Machines', 'KNN', 'Logistic Regression',
              'Random Forest', 'Naive Bayes', 'Perceptron',
              'Stochastic Gradient Decent',
              'Decision Tree'],
    'Score': [acc_linear_svc, acc_knn, acc_log,
              acc_random_forest, acc_gaussian, acc_perceptron,
              acc_sgd, acc_decision_tree]})
result_df = results.sort_values(by='Score', ascending=False)
result_df = result_df.set_index('Score')
result_df.head(9)
```

Score	Model
98.61	KNN
98.61	Random Forest
98.61	Decision Tree
71.83	Naive Bayes
65.08	Logistic Regression
64.29	Support Vector Machines
49.01	Stochastic Gradient Decent
45.34	Perceptron

Next steps: Generate code with `result_df` | View recommended plots | New interactive sheet

```
importances.plot.bar()
```

```
<Axes: xlabel='feature'>
```




```
!pip install dash

from dash import dcc

def feature_importance():
    return importances
colnames=['FactorHps','ActivityHps','PriceHps','InnovationHps']
xts = pd.DataFrame(np.array([[1,1,1,1]]),columns=colnames)
```

```
#xts = np.unique(['NumberHps', 'NumberHps', 'TimeHps'])
xts
```

```
Collecting dash
  Downloading dash-2.18.1-py3-none-any.whl.metadata (10 kB)
Requirement already satisfied: Flask<3.1,>=1.0.4 in /usr/local/lib/python3.10/dist-packages (from dash) (2.2.5)
Requirement already satisfied: Werkzeug<3.1 in /usr/local/lib/python3.10/dist-packages (from dash) (3.0.4)
Requirement already satisfied: plotly>=5.0.0 in /usr/local/lib/python3.10/dist-packages (from dash) (5.24.1)
Collecting dash-html-components==2.0.0 (from dash)
  Downloading dash_html_components-2.0.0-py3-none-any.whl.metadata (3.8 kB)
Collecting dash-core-components==2.0.0 (from dash)
  Downloading dash_core_components-2.0.0-py3-none-any.whl.metadata (2.9 kB)
Collecting dash-table==5.0.0 (from dash)
  Downloading dash_table-5.0.0-py3-none-any.whl.metadata (2.4 kB)
Requirement already satisfied: importlib-metadata in /usr/local/lib/python3.10/dist-packages (from dash) (8.4.0)
Requirement already satisfied: typing-extensions>=4.1.1 in /usr/local/lib/python3.10/dist-packages (from dash) (4.12.2)
Requirement already satisfied: requests in /usr/local/lib/python3.10/dist-packages (from dash) (2.32.3)
Collecting retrying (from dash)
  Downloading retrying-1.3.4-py3-none-any.whl.metadata (6.9 kB)
Requirement already satisfied: nest-asyncio in /usr/local/lib/python3.10/dist-packages (from dash) (1.6.0)
Requirement already satisfied: setuptools in /usr/local/lib/python3.10/dist-packages (from dash) (71.0.4)
Requirement already satisfied: Jinja2>=3.0 in /usr/local/lib/python3.10/dist-packages (from Flask<3.1,>=1.0.4->dash) (3.1.4)
Requirement already satisfied: itsdangerous>=2.0 in /usr/local/lib/python3.10/dist-packages (from Flask<3.1,>=1.0.4->dash) (2.2.0)
Requirement already satisfied: click>=8.0 in /usr/local/lib/python3.10/dist-packages (from Flask<3.1,>=1.0.4->dash) (8.1.7)
Requirement already satisfied: tenacity>=6.2.0 in /usr/local/lib/python3.10/dist-packages (from plotly>=5.0.0->dash) (9.0.0)
Requirement already satisfied: packaging in /usr/local/lib/python3.10/dist-packages (from plotly>=5.0.0->dash) (24.1)
Requirement already satisfied: MarkupSafe>=2.1.1 in /usr/local/lib/python3.10/dist-packages (from Werkzeug<3.1->dash) (2.1.5)
Requirement already satisfied: zipp>=0.5 in /usr/local/lib/python3.10/dist-packages (from importlib-metadata->dash) (3.20.2)
Requirement already satisfied: charset-normalizer<4,>=2 in /usr/local/lib/python3.10/dist-packages (from requests->dash) (3.3.2)
Requirement already satisfied: idna<4,>=2.5 in /usr/local/lib/python3.10/dist-packages (from requests->dash) (3.10)
Requirement already satisfied: urllib3<3,>=1.21.1 in /usr/local/lib/python3.10/dist-packages (from requests->dash) (2.2.3)
Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.10/dist-packages (from requests->dash) (2024.8.30)
Requirement already satisfied: six>=1.7.0 in /usr/local/lib/python3.10/dist-packages (from retrying->dash) (1.16.0)
Downloading dash-2.18.1-py3-none-any.whl (7.5 MB)
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 7.5/7.5 MB 22.6 MB/s eta 0:00:00
Downloading dash_core_components-2.0.0-py3-none-any.whl (3.8 kB)
Downloading dash_html_components-2.0.0-py3-none-any.whl (4.1 kB)
Downloading dash_table-5.0.0-py3-none-any.whl (3.9 kB)
Downloading retrying-1.3.4-py3-none-any.whl (11 kB)
Installing collected packages: dash-table, dash-html-components, dash-core-components, retrying, dash
Successfully installed dash-2.18.1 dash-core-components-2.0.0 dash-html-components-2.0.0 dash-table-5.0.0 retrying-1.3.4
```

	FactorHps	ActivityHps	PriceHps	InnovationHps
0	1	1	1	1

```
def predict_input(que1,que2,que3,que4,ans1,ans2,ans3,ans4):
    X1=({que1: [ans1],
        que2: [ans2],
        que3: [ans3],
        que4: [ans4]})

    #X1 = ({'Gender':[0], 'Age': [2], 'Status':[0], 'Education':[1],'Occupation': [2]})

    dfs = pd.DataFrame(X1)

    return dfs
```

```
def MLdecision_tree(xtest):
    X_train = train_df[xtest.columns.values]
    Y_train = train_df["HpAnswer"]
    random_forest = RandomForestClassifier(n_estimators=100)

    X_test  = test_df[xtest.columns.values]
    Y_test  = test_df["HpAnswer"]
    random_forest.fit(X_train, Y_train)
    Y_pred = random_forest.predict(X_test)
    Y3           = random_forest.predict_proba(X_test)

    Y_train = train_df["HpAnswer"]
    random_forest.fit(X_train, Y_train)
    Y_pred_hp = random_forest.predict(xtest)
    Y3           = random_forest.predict_proba(xtest)
    acc_random_forest = round(random_forest.score(X_train, Y_train) * 100, 2)
    print("acc_random_forest_hp:",acc_random_forest)

    Y_train = train_df["Gender"]
    random_forest.fit(X_train, Y_train)
    Y_pred_gender = random_forest.predict(xtest)
    acc_random_forest = round(random_forest.score(X_train, Y_train) * 100, 2)
    print("acc_random_forest_gender:",acc_random_forest)

    Y_train = train_df["Age"]
    random_forest.fit(X_train, Y_train)
```

```
    Y_pred_age = random_forest.predict(xtest)
    acc_random_forest = round(random_forest.score(X_train, Y_train) * 100, 2)
    print("acc_random_forest_age:",acc_random_forest)

    Y_train = train_df["Status"]
    random_forest.fit(X_train, Y_train)
    Y_pred_status = random_forest.predict(xtest)
    acc_random_forest = round(random_forest.score(X_train, Y_train) * 100, 2)
    print("acc_random_forest_status:",acc_random_forest)

    Y_train = train_df["Education"]
    random_forest.fit(X_train, Y_train)
    Y_pred_edu = random_forest.predict(xtest)
    acc_random_forest = round(random_forest.score(X_train, Y_train) * 100, 2)
    print("acc_random_forest_edu:",acc_random_forest)

    Y_train = train_df["Occupation"]
    random_forest.fit(X_train, Y_train)
    Y_pred_occ = random_forest.predict(xtest)
    acc_random_forest = round(random_forest.score(X_train, Y_train) * 100, 2)
    print("acc_random_forest_occ:",acc_random_forest)

    if Y_pred_hp[0] == 1 : charac_hp = "HP1"
    if Y_pred_hp[0] == 2 : charac_hp = "HP2"
    if Y_pred_hp[0] == 3 : charac_hp = "HP3"

    if Y_pred_gender[0] == 0 : charac_gender = "female"
    if Y_pred_gender[0] == 1 : charac_gender = "male"

    if Y_pred_age[0] == 1 : charac_age = "20-27"
    if Y_pred_age[0] == 2 : charac_age = "28-35"
    if Y_pred_age[0] == 3 : charac_age = "36-45"

    if Y_pred_status[0] == 0 : charac_status = "single"
    if Y_pred_status[0] == 1 : charac_status = "married"

    if Y_pred_edu[0] == 1 : charac_edu = "graduate"
    if Y_pred_edu[0] == 2 : charac_edu = "undergraduate"
    if Y_pred_edu[0] == 3 : charac_edu = "high school"
    if Y_pred_edu[0] == 4 : charac_edu = "unspecified education"

    if Y_pred_occ[0] == 1 : charac_occ = "student"
    if Y_pred_occ[0] == 2 : charac_occ = "employee"
    if Y_pred_occ[0] == 3 : charac_occ = "business owner"
    if Y_pred_occ[0] == 4 : charac_occ = "unspecified occupation"

    #acc_decision_tree = round(decision_tree.score(X_train, Y_train) * 100, 2)
    print(classification_report(Y_test, Y_pred))
    #print("acc_decision_tree:",label,acc_decision_tree)
    #print(Y_pred,Y3)
    return charac_hp,charac_gender,charac_age,charac_status,charac_edu,charac_occ,Y_pred_hp[0],Y_pred_gender[0],\
          Y_pred_age[0],Y_pred_status[0],Y_pred_occ[0],Y_pred_edu[0],Y3
```

```
MLdecision_tree(xts)
```

```
acc_random_forest_hp: 92.96
acc_random_forest_gender: 96.33
acc_random_forest_age: 94.74
acc_random_forest_status: 97.52
acc_random_forest_edu: 90.08
acc_random_forest_occ: 94.35
              precision    recall  f1-score   support

           1       0.88      0.76      0.81        58
           2       0.91      0.98      0.94       245
           3       1.00      0.93      0.96       129

    accuracy                           0.93       432
   macro avg       0.93      0.89      0.91       432
weighted avg       0.93      0.93      0.93       432

('HP2',
 'female',
 '36-45',
 'married',
 'high school',
 'unspecified occupation',
 2,
 0,
 3,
 1,
 4,
 3,
 array([[0.06, 0.94, 0.  ]]))
```

```
dfs = predict_input('FactorHps','ActivityHps','PriceHps','InnovationHps',2,1,1,2)
dfs.columns.values
```

```
array(['FactorHps', 'ActivityHps', 'PriceHps', 'InnovationHps'],
      dtype=object)
```

```
# X_train = train_df.drop("HpAnswer", axis=1)
# Y_train = train_df[["HpAnswer"]]
# X_test  = test_df.drop("HpAnswer", axis=1)
# Y_test  = test_df[["HpAnswer"]]
xt = pd.DataFrame([{'FactorHps':1,'PriceHps':2,'ActivityHps':3}])
xt.columns.values
```

```
array(['FactorHps', 'PriceHps', 'ActivityHps'], dtype=object)
```

```
from sklearn.preprocessing import LabelBinarizer

label_binarizer = LabelBinarizer().fit(Y_train)
y_onehot_test = label_binarizer.transform(Y_test)
y_onehot_test.shape  # (n_samples, n_classes)

#label_binarizer.transform([1])
```

```
(432, 3)
```

```
# class_of_interest = 1
# class_id = np.flatnonzero(label_binarizer.classes_ == class_of_interest)[0]
# class_id
```

```
import plotly.express as px
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import roc_curve, auc
from sklearn.datasets import make_classification

from sklearn.metrics import RocCurveDisplay
from sklearn.metrics import roc_auc_score
from sklearn.preprocessing import LabelBinarizer
# df3 = pd.concat([df]*20, ignore_index=True)

# train_df,test_df = train_test_split(df3, test_size=0.3, random_state=42, shuffle=True)
# features = ['FactorHps','PriceHps','ActivityHps']
# X_train = train_df[features]
# Y_train = train_df["HpAnswer"]
# X_test  = test_df[features]
# Y_test  = test_df["HpAnswer"]

# decision_tree = DecisionTreeClassifier()
# decision_tree.fit(X_train, Y_train)
# y_score = decision_tree.fit(X_train, Y_train).predict_proba(X_test)

def getROCfigure(htype,features,label,tname):
    df3 = pd.concat([df]*20, ignore_index=True)

    train_df,test_df = train_test_split(df3, test_size=0.3, random_state=42, shuffle=True)

    X_train = train_df[features]
    Y_train = train_df[label]
    X_test  = test_df[features]
    Y_test  = test_df[label]
    decision_tree = DecisionTreeClassifier()
    decision_tree.fit(X_train, Y_train)
    if(label == "HpAnswer") or (label == "Age") or (label == "Education") or (label == "Occupation"):

        label_binarizer = LabelBinarizer().fit(Y_train)
        y_onehot_test = label_binarizer.transform(Y_test)
        y_onehot_test.shape  # (n_samples, n_classes)

        class_of_interest = int(htype)
        y_score = decision_tree.fit(X_train, Y_train).predict_proba(X_test)
        class_id = np.flatnonzero(label_binarizer.classes_ == class_of_interest)[0]

        y_score = decision_tree.fit(X_train, Y_train).predict_proba(X_test)
        fpr, tpr, thresholds = roc_curve(y_onehot_test[:, class_id], y_score[:, class_id])
        fig = px.area(
            x=fpr, y=tpr,
            title=f'<b>ROC Curve (AUC={auc(fpr, tpr):.4f}){tname}</b>',
            labels=dict(x='False Positive Rate', y='True Positive Rate'),
            width=700, height=500
         )
```

```
    if (label == "Gender"):
        y_score = decision_tree.fit(X_train, Y_train).predict_proba(X_test)[:,1]
        fpr, tpr, thresholds = roc_curve(np.array(Y_test), y_score)
        fig = px.area(
            x=fpr, y=tpr,
            title=f'<b>ROC Curve (AUC={auc(fpr, tpr):.4f}) of Female 0 - Male 1</b>',
            labels=dict(x='False Positive Rate', y='True Positive Rate'),
            width=700, height=500
         )
    if (label == "Status"):
        y_score = decision_tree.fit(X_train, Y_train).predict_proba(X_test)[:,1]
        fpr, tpr, thresholds = roc_curve(np.array(Y_test), y_score)
        fig = px.area(
            x=fpr, y=tpr,
            title=f'<b>ROC Curve(AUC={auc(fpr, tpr):.3f})Single 0-Married 1</b>',
            labels=dict(x='False Positive Rate', y='True Positive Rate'),
            width=700, height=500
         )
    fig.add_shape(
        type='line', line=dict(dash='dash'),
        x0=0, x1=1, y0=0, y1=1
    )
    fig.update_layout(width=270,height=270, font=dict(size=7),margin=dict(l=10, r=10, t=30, b=10))
    fig.update_yaxes(scaleanchor="x", scaleratio=1)
    fig.update_xaxes(constrain='domain')
    return fig
```

```
getROCfigure(1,['FactorHps','PriceHps','ActivityHps'],'Status',0)
```


```
getROCfigure(1,['FactorHps','PriceHps','ActivityHps'],'HpAnswer','HP1')
```


```
getROCfigure(2,['FactorHps','PriceHps','ActivityHps'],'HpAnswer','HP2')
```


```
getROCfigure(3,xt.columns.values,'HpAnswer','HP3')
```


```
import plotly.graph_objects as go
import plotly.express as px
import numpy as np
import pandas as pd
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import roc_curve, roc_auc_score

def getROCfigure2(features,label):

    df3 = pd.concat([df]*20, ignore_index=True)

    train_df,test_df = train_test_split(df3, test_size=0.3, random_state=42, shuffle=True)

    X_train = train_df[features]
    Y_train = train_df[label]
    decision_tree = DecisionTreeClassifier()
    decision_tree.fit(X_train, Y_train)

    y_scores = decision_tree.predict_proba(X_train)
    # One hot encode the labels in order to plot them
    y_onehot = pd.get_dummies(Y_train, columns=decision_tree.classes_)
    # Create an empty figure, and iteratively add new lines
    # every time we compute a new class
    fig = go.Figure()
    fig.add_shape(
        type='line', line=dict(dash='dash'),
        x0=0, x1=1, y0=0, y1=1
    )

    for i in range(y_scores.shape[1]):
        y_true = y_onehot.iloc[:, i]
        y_score = y_scores[:, i]

        fpr, tpr, _ = roc_curve(y_true, y_score)
        auc_score = roc_auc_score(y_true, y_score)

        if(label == "HpAnswer"):
            if y_onehot.columns[i] == 1 : attrcol = "HP1"
            if y_onehot.columns[i] == 2 : attrcol = "HP2"
            if y_onehot.columns[i] == 3 : attrcol = "HP3"
        elif(label == "Gender"):
            if y_onehot.columns[i] == 0 : attrcol = "F"
            if y_onehot.columns[i] == 1 : attrcol = "M"
        elif(label == "Age"):
            if y_onehot.columns[i] == 1 : attrcol = "20-27"
            if y_onehot.columns[i] == 2 : attrcol = "28-35"
```

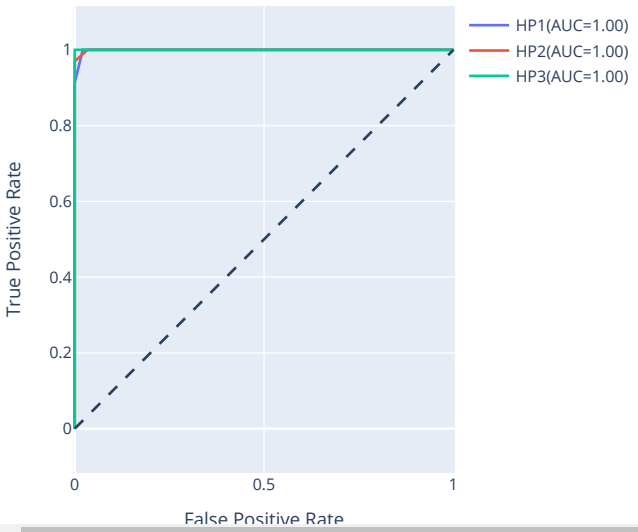
```
            if y_onehot.columns[i] == 3 : attrcol = "36-45"
        elif(label == "Status"):
            if y_onehot.columns[i] == 0 : attrcol = "S"
            if y_onehot.columns[i] == 1 : attrcol = "M"
        elif(label == "Education"):
            if y_onehot.columns[i] == 1 : attrcol = "G"
            if y_onehot.columns[i] == 2 : attrcol = "U"
            if y_onehot.columns[i] == 3 : attrcol = "H"
            if y_onehot.columns[i] == 4 : attrcol = "O"
        elif(label == "Occupation"):
            if y_onehot.columns[i] == 1 : attrcol = "S"
            if y_onehot.columns[i] == 2 : attrcol = "E"
            if y_onehot.columns[i] == 3 : attrcol = "B"
            if y_onehot.columns[i] == 4 : attrcol = "O"

        name = f"{attrcol}(AUC={auc_score:.2f})"
        fig.add_trace(go.Scatter(x=fpr, y=tpr, name=name, mode='lines'))
    if(label == "HpAnswer"):
        labels="Headphone Type"
    else:
        labels= label
    fig.update_layout(
        xaxis_title='False Positive Rate',
        yaxis_title='True Positive Rate',
        title=f'ROC Curve of {labels}',
        yaxis=dict(scaleanchor="x", scaleratio=1),
        xaxis=dict(constrain='domain'),
        width=500,height=450,
        font=dict(size=12),margin=dict(l=10, r=10, t=50, b=10))
    return fig

def getROCfigure3(features,label,tname):

    df3 = pd.concat([df]*20, ignore_index=True)

    train_df,test_df = train_test_split(df3, test_size=0.3, random_state=42, shuffle=True)

    X_train = train_df[features]
    Y_train = train_df[label]
    X_test  = test_df[features]
    Y_test  = test_df[label]
    decision_tree = DecisionTreeClassifier()
    decision_tree.fit(X_train, Y_train)
    # # Fit the model
    # model = LogisticRegression(max_iter=200)
    # model.fit(X, y)
    y_scores = decision_tree.predict_proba(X_test)
    # One hot encode the labels in order to plot them
    y_onehot = pd.get_dummies(Y_test, columns=decision_tree.classes_)

    # Create an empty figure, and iteratively add new lines
    # every time we compute a new class
    fig = go.Figure()
    fig.add_shape(
        type='line', line=dict(dash='dash'),
        x0=0, x1=1, y0=0, y1=1
    )

    for i in range(y_scores.shape[1]):
        y_true = y_onehot.iloc[:, i]
        y_score = y_scores[:, i]

        fpr, tpr, _ = roc_curve(y_true, y_score)
        auc_score = roc_auc_score(y_true, y_score)

        name = f"{y_onehot.columns[i]}(AUC={auc_score:.2f})"
        fig.add_trace(go.Scatter(x=fpr, y=tpr, name=name, mode='lines'))

    fig.update_layout(
        xaxis_title='False Positive Rate',
        yaxis_title='True Positive Rate',
        title=f'ROC Curve of {tname}',
        yaxis=dict(scaleanchor="x", scaleratio=1),
        xaxis=dict(constrain='domain'),
        font=dict(size=12),margin=dict(l=10, r=10, t=50, b=10))
    return fig
```

```
colname
```

```
['ActivityHps',
 'PriceHps',
```

```
    'PlaceHps',
    'FactorHps',
    'InnovationHps',
    'InfoHps_online',
    'InfoHps_Store',
    'InfoHps_PR']
```

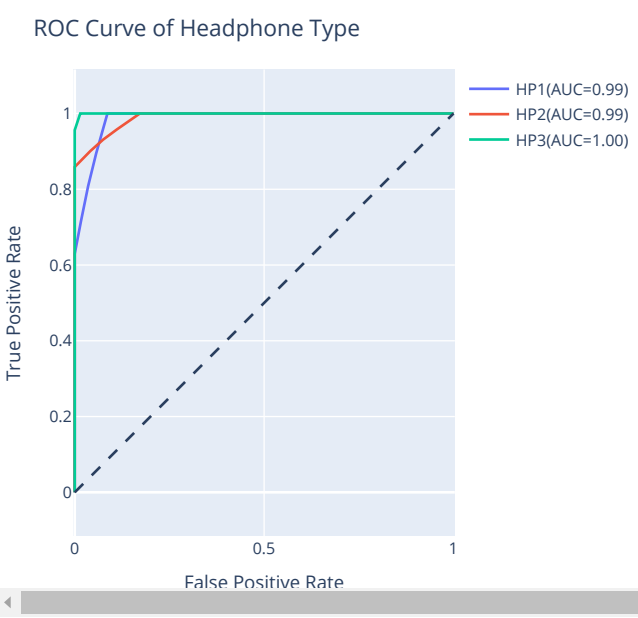
```
getROCfigure2(colname,'HpAnswer')
```




```
colnames
```

```
['FactorHps', 'ActivityHps', 'PriceHps', 'InnovationHps']
```

```
getROCfigure2(colnames,'HpAnswer')
```




```
from sklearn.metrics import confusion_matrix
import plotly.graph_objects as go
import plotly.express as px

def getConfusionMatrix(features,label):

    df3 = pd.concat([df]*20, ignore_index=True)

    train_df,test_df = train_test_split(df3, test_size=0.3, random_state=42, shuffle=True)

    X_train = train_df[features]
    Y_train = train_df[label]
    X_test  = test_df[features]
    Y_test  = test_df[label]
```

```
    decision_tree = DecisionTreeClassifier()
    decision_tree.fit(X_train, Y_train)
    Y_pred = decision_tree.predict(X_test)
    cm = confusion_matrix(Y_test,Y_pred,normalize='true')
    cm1 = np.round(cm,2)
    #print(Y_train.value_counts().index.shape[0])
    #list(map(str,Y_train.value_counts().index.sort_values()))
    if(label == "HpAnswer"):
        ac = ['HP1','HP2','HP3']
    elif(label == "Gender"):
        ac = ['F','M']
    elif(label == "Age"):
        ac = ['20-27','28-35', '36-45']
    elif(label == "Status"):
        ac = ['S','M']
    elif(label == "Education"):
        ac = ['G','U','H','O']
    elif(label == "Occupation"):
        if(Y_train.value_counts().index.shape[0]==3):
           ac = ['E','B','O']
        else:
           ac = ['S','E','B','O']

    fig = px.imshow(cm1,
                    labels=dict(x="Predicted label", y="True label"),
                    color_continuous_scale='blues',
                    aspect="auto",
                    x = ac,
                    y = ac,
                  # title='Normalized confusion matrix',
                    text_auto=True)
    fig.update_xaxes(side="bottom")
    fig.update_layout(width=300,height=300, font=dict(size=12),margin=dict(l=10, r=10, t=10, b=10))
    fig.update_coloraxes(showscale=False)

    return fig
```

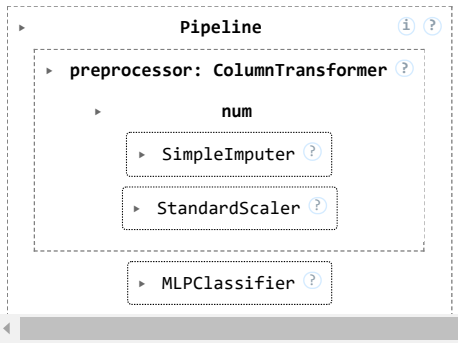
```
getConfusionMatrix(colnames,'HpAnswer')
```


```
!pip install dalex

import dalex as dx


from sklearn.neural_network import MLPClassifier
from sklearn.preprocessing import StandardScaler, OneHotEncoder
from sklearn.impute import SimpleImputer
from sklearn.pipeline import Pipeline
from sklearn.compose import ColumnTransformer

import warnings
warnings.filterwarnings('ignore')

df3 = pd.concat([df]*20, ignore_index=True)

train_df,test_df = train_test_split(df3, test_size=0.3, random_state=42, shuffle=True)

X = train_df[['Gender','Age','Status','Education','Occupation','FactorHps', 'ActivityHps', 'PriceHps']]
y = train_df["HealthHps"]

numerical_features = ['Gender','Age','Status','Education','Occupation','FactorHps', 'ActivityHps', 'PriceHps']
numerical_transformer = Pipeline(
    steps=[
```

```
        ('imputer', SimpleImputer(strategy='median')),
        ('scaler', StandardScaler())
    ]
)

# categorical_features = ['gender', 'class', 'embarked']
# categorical_transformer = Pipeline(
#     steps=[
#         ('imputer', SimpleImputer(strategy='constant', fill_value='missing')),
#         ('onehot', OneHotEncoder(handle_unknown='ignore'))
#     ]
# )

preprocessor = ColumnTransformer(
    transformers=[
        ('num', numerical_transformer, numerical_features),
       # ('cat', categorical_transformer, categorical_features)
    ]
)

classifier = MLPClassifier(hidden_layer_sizes=(150,100,50), max_iter=500, random_state=0)

clf = Pipeline(steps=[('preprocessor', preprocessor),
                      ('classifier', classifier)])
```

```
Collecting dalex
  Downloading dalex-1.7.1.tar.gz (1.0 MB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 1.0/1.0 MB 10.9 MB/s eta 0:00:00
  Preparing metadata (setup.py) ... done
Requirement already satisfied: setuptools in /usr/local/lib/python3.10/dist-packages (from dalex) (71.0.4)
Requirement already satisfied: pandas>=1.5.3 in /usr/local/lib/python3.10/dist-packages (from dalex) (2.2.2)
Requirement already satisfied: numpy>=1.23.3 in /usr/local/lib/python3.10/dist-packages (from dalex) (1.26.4)
Requirement already satisfied: scipy>=1.6.3 in /usr/local/lib/python3.10/dist-packages (from dalex) (1.13.1)
Requirement already satisfied: plotly>=5.1.0 in /usr/local/lib/python3.10/dist-packages (from dalex) (5.24.1)
Requirement already satisfied: tqdm>=4.61.2 in /usr/local/lib/python3.10/dist-packages (from dalex) (4.66.5)
Requirement already satisfied: python-dateutil>=2.8.2 in /usr/local/lib/python3.10/dist-packages (from pandas>=1.5.3->dalex) (2.8.2
Requirement already satisfied: pytz>=2020.1 in /usr/local/lib/python3.10/dist-packages (from pandas>=1.5.3->dalex) (2024.2)
Requirement already satisfied: tzdata>=2022.7 in /usr/local/lib/python3.10/dist-packages (from pandas>=1.5.3->dalex) (2024.2)
Requirement already satisfied: tenacity>=6.2.0 in /usr/local/lib/python3.10/dist-packages (from plotly>=5.1.0->dalex) (9.0.0)
Requirement already satisfied: packaging in /usr/local/lib/python3.10/dist-packages (from plotly>=5.1.0->dalex) (24.1)
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.10/dist-packages (from python-dateutil>=2.8.2->pandas>=1.5.3->dale
Building wheels for collected packages: dalex
  Building wheel for dalex (setup.py) ... done
  Created wheel for dalex: filename=dalex-1.7.1-py3-none-any.whl size=1042797 sha256=546a40718b6cddd6e6114a78fdef5e7c3d6878263fdf5c4
  Stored in directory: /root/.cache/pip/wheels/fe/c2/41/63e006b3312a4e17299bed5f83d985dea872368f9ab16bb20f
Successfully built dalex
Installing collected packages: dalex
Successfully installed dalex-1.7.1
```

```
clf.fit(X, y)
```




```
exp = dx.Explainer(clf, X, y)
```

```
Preparation of a new explainer is initiated

  -> data              : 1008 rows 8 cols
  -> target variable   : Parameter 'y' was a pandas.Series. Converted to a numpy.ndarray.
  -> target variable   : 1008 values
  -> model_class       : sklearn.neural_network._multilayer_perceptron.MLPClassifier (default)
  -> label             : Not specified, model's class short name will be used. (default)
  -> predict function  : <function yhat_proba_default at 0x7b71e9f588b0> will be used (default)
  -> predict function  : Accepts only pandas.DataFrame, numpy.ndarray causes problems.
  -> predicted values  : min = 4.02e-08, mean = 0.614, max = 1.0
  -> model type        : classification will be used (default)
  -> residual function : difference between y and yhat (default)
  -> residuals         : min = -0.323, mean = 0.00474, max = 0.677
```

```
  -> model_info        : package sklearn

A new explainer has been created!
```

```
# ['Gender','Age','Status','Education','Occupation','HpAnswer','NumberHps', 'ActivityHps', 'TimeHps',\
#                       'PriceHps','PlaceHps','FactorHps','HealthHps','InnovationHps',"PB_nosound","PB_disconnect","PB_badsound",\
#                       "PB_unfit","PB_oneear","PB_toosd","PB_audiocut","PB_battery","PB_unplug","InfoHps_online",\
#                       "InfoHps_Social","InfoHps_Google","InfoHps_Store","InfoHps_PR","InfoHps_Ads"]

me = pd.DataFrame({'Gender': [0],
                   'Age': [2],
                   'Status': [1],
                   'Education':[2],
                   'Occupation':[2],
                   'FactorHps':[1],
                   'ActivityHps':[2],
                   'PriceHps':[1]},
                    index = ['Me'])
```

```
exp.predict(me)
```

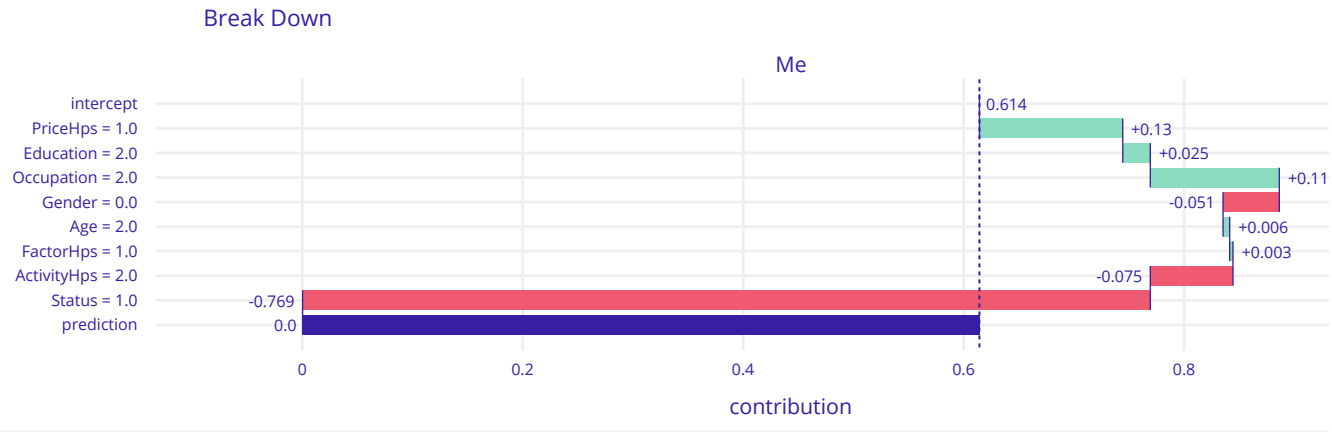
```
array([6.92954416e-05])
```

```
bd_me = exp.predict_parts(me, type='break_down', label=me.index[0])
# bd_interactions_me = exp.predict_parts(me, type='break_down_interactions', label="me+")

# sh_me = exp.predict_parts(me, type='shap', B = 10, label=me.index[0])
```

```
bd_me.result
```

	variable_name	variable_value	variable	cumulative	contribution	sign	position	label
0	intercept		intercept	0.614307	0.614307	1.0	9	Me
1	PriceHps	1.0	PriceHps = 1.0	0.743928	0.129621	1.0	8	Me
2	Education	2.0	Education = 2.0	0.769384	0.025456	1.0	7	Me
3	Occupation	2.0	Occupation = 2.0	0.885900	0.116516	1.0	6	Me
4	Gender	0.0	Gender = 0.0	0.834517	-0.051383	-1.0	5	Me
5	Age	2.0	Age = 2.0	0.840359	0.005843	1.0	4	Me
6	FactorHps	1.0	FactorHps = 1.0	0.843857	0.003498	1.0	3	Me
7	ActivityHps	2.0	ActivityHps = 2.0	0.768682	-0.075175	-1.0	2	Me
8	Status	1.0	Status = 1.0	0.000069	-0.768613	-1.0	1	Me
9			prediction	0.000069	0.000069	1.0	0	Me

```
bd_me.plot()
```




```
import dalex as dx

from sklearn.neural_network import MLPClassifier
from sklearn.preprocessing import StandardScaler, OneHotEncoder
from sklearn.impute import SimpleImputer
```

```
from sklearn.pipeline import Pipeline
from sklearn.compose import ColumnTransformer
from sklearn.ensemble import RandomForestClassifier

import warnings
warnings.filterwarnings('ignore')

X = train_df[['Gender','Age','Status','Education','Occupation','FactorHps', 'ActivityHps', 'PriceHps', 'InnovationHps']]
y = train_df["HpAnswer"]

model = RandomForestClassifier(n_estimators=100)
model.fit(X, y)
model.predict_proba(X).shape
```

```
(1008, 3)
```

```
# custom (binary) predict function
pf_0 = lambda m, d: m.predict_proba(d)[:, 0]

# custom (binary) target values
y_0 = y == 1

# explainer
exp_0 = dx.Explainer(model, X, y_0, predict_function=pf_0, label="RFClassifier: class 0")
```

```
Preparation of a new explainer is initiated

  -> data              : 1008 rows 9 cols
  -> target variable   : Parameter 'y' was a pandas.Series. Converted to a numpy.ndarray.
  -> target variable   : 1008 values
  -> model_class       : sklearn.ensemble._forest.RandomForestClassifier (default)
  -> label             : RFClassifier: class 0
  -> predict function  : <function <lambda> at 0x7b71e875ec20> will be used
  -> predict function  : Accepts pandas.DataFrame and numpy.ndarray.
  -> predicted values  : min = 0.0, mean = 0.161, max = 1.0
  -> model type        : classification will be used (default)
  -> residual function : difference between y and yhat (default)
  -> residuals         : min = 0.0, mean = 0.0, max = 0.0
  -> model_info        : package sklearn

A new explainer has been created!
```

```
exp_0.model_parts()
```

	variable	dropout_loss	label
0	Gender	0.000000	RFClassifier: class 0
1	Occupation	0.000000	RFClassifier: class 0
2	Status	0.000000	RFClassifier: class 0
3	_full_model_	0.000000	RFClassifier: class 0
4	Age	0.000351	RFClassifier: class 0
5	InnovationHps	0.004555	RFClassifier: class 0
6	ActivityHps	0.014264	RFClassifier: class 0
7	FactorHps	0.032544	RFClassifier: class 0
8	Education	0.062144	RFClassifier: class 0
9	PriceHps	0.067768	RFClassifier: class 0
10	baseline	0.507549	RFClassifier: class 0

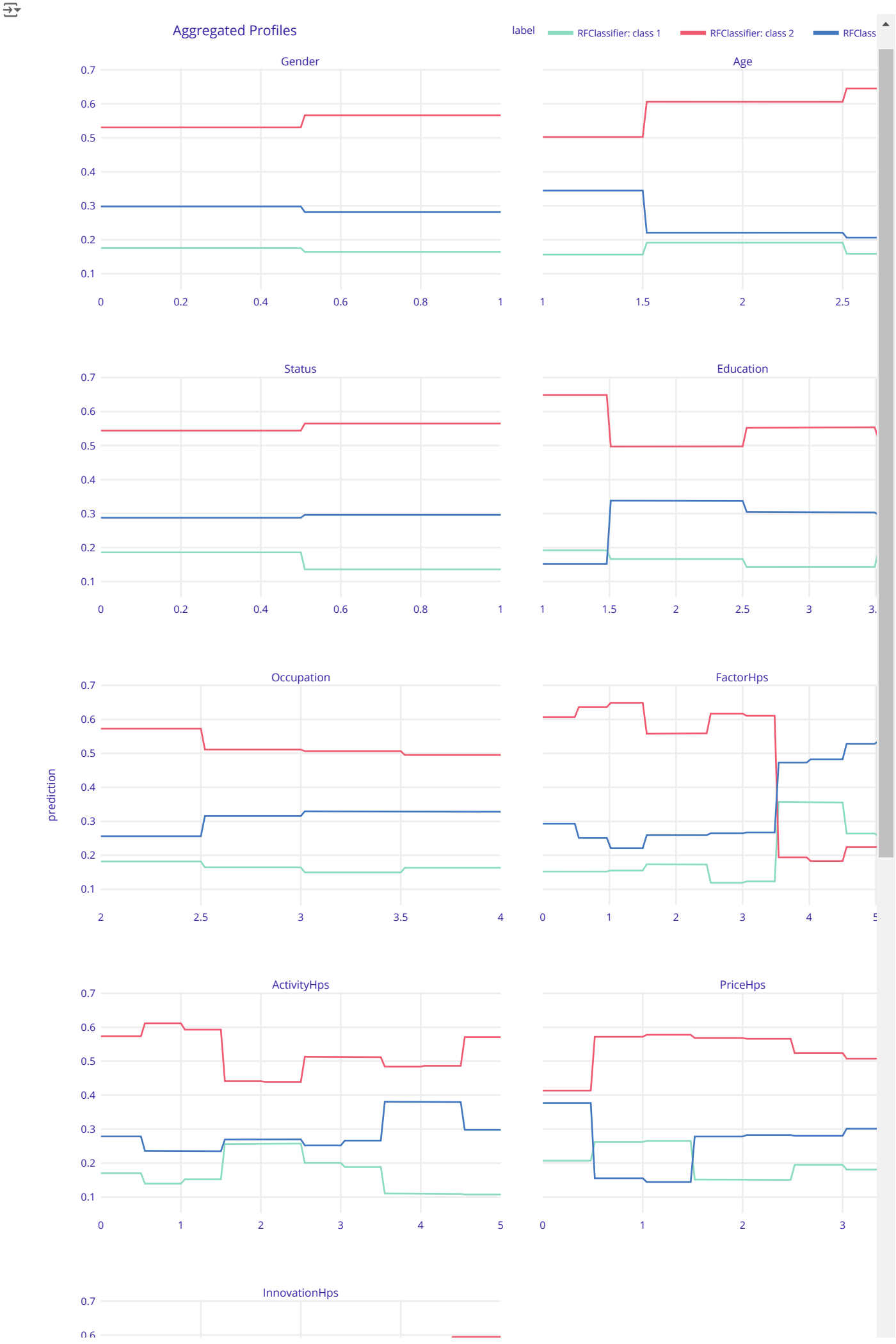
```
exp_list = []

for i in range(len(np.unique(y))):
    # add i parameter to `predict_function` just to do it in a loop
    pf = lambda m, d, i=i: m.predict_proba(d)[:, i]
    e = dx.Explainer(
        model, X,
        y == i+1,
        predict_function=pf,
        label=f'RFClassifier: class {i+1}',
        verbose=False
    )
    exp_list += [e]

exp_list
```

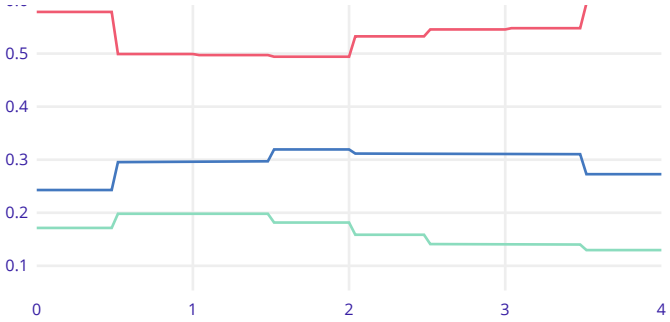
```
[<dalex._explainer.object.Explainer at 0x7b71e876c7f0>,
 <dalex._explainer.object.Explainer at 0x7b71e876fc70>,
 <dalex._explainer.object.Explainer at 0x7b71e876e650>]
```

```
m_profile_list = [e.model_profile() for e in exp_list]
```

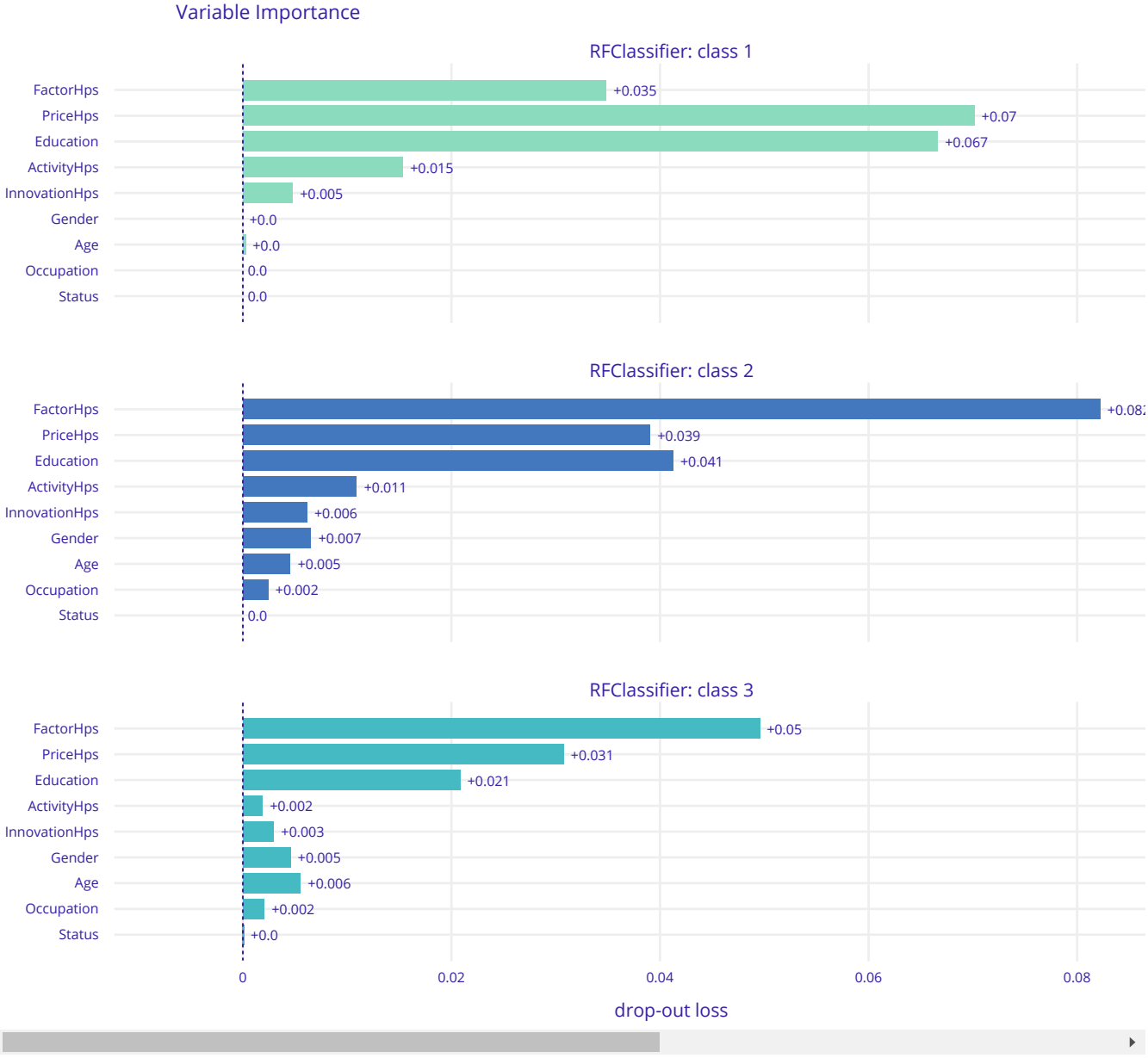
```
Calculating ceteris paribus: 100%|██████████| 9/9 [00:06<00:00,  1.34it/s]
Calculating ceteris paribus: 100%|██████████| 9/9 [00:10<00:00,  1.15s/it]
Calculating ceteris paribus: 100%|██████████| 9/9 [00:06<00:00,  1.31it/s]
```

```
m_profile_list[0].plot(m_profile_list[1:])
```


Aggregated Profiles
label
RFClassifier: class 1
RFClassifier: class 2
RFClass
Gender
Age
Status
Education
Occupation
FactorHps
ActivityHps
PriceHps
InnovationHps
prediction




```
m_parts_list = [e.model_parts() for e in exp_list]
m_parts_list[0].plot(m_parts_list[1:])
```



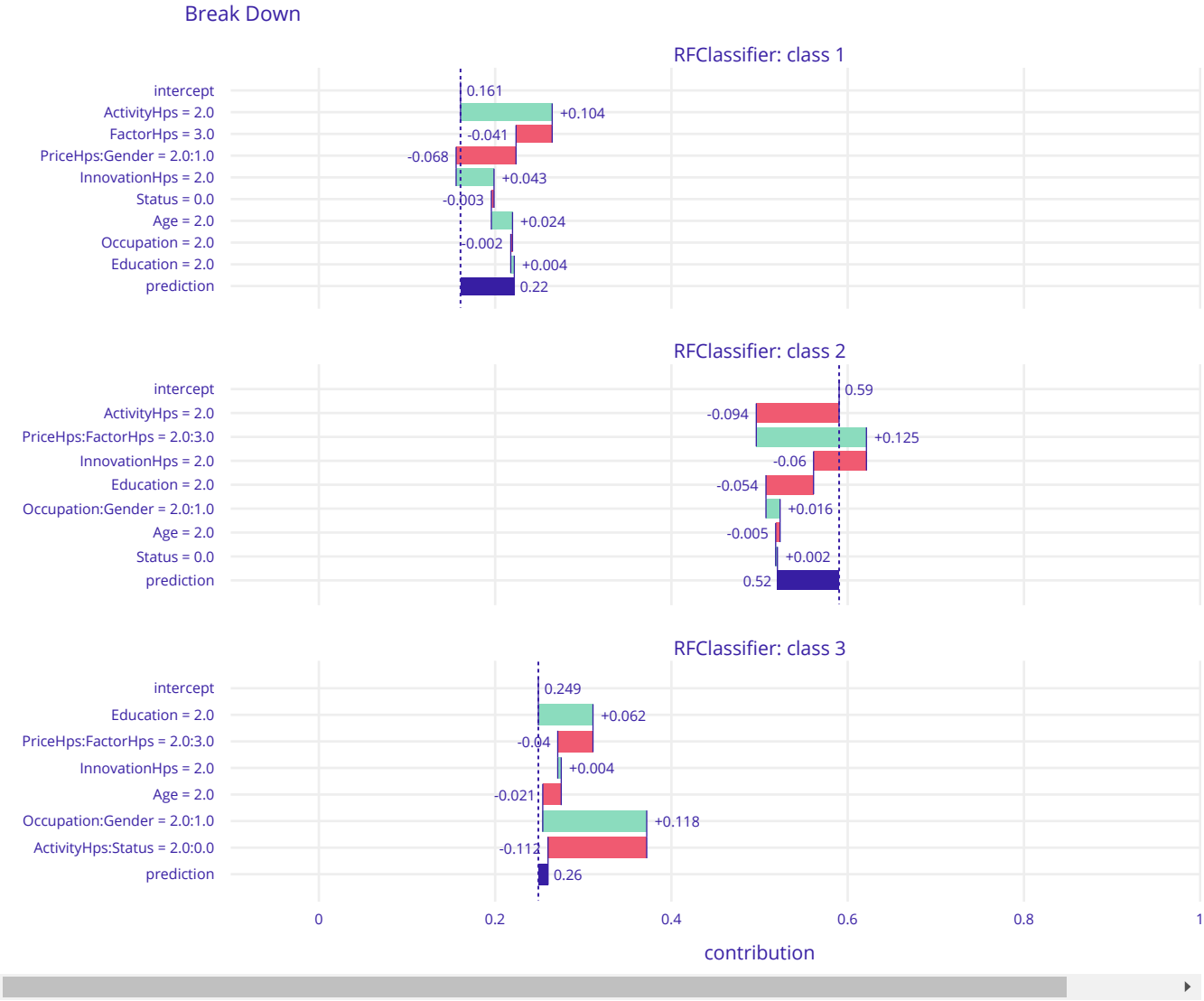

```
# choose a data point to explain
# observation = X.iloc[[0]]
# observation
observation = pd.DataFrame({'Gender': [1],
                   'Age': [2],
                   'Status': [0],
                   'Education':[2],
                   'Occupation':[2],
                   'FactorHps':[3],
                   'ActivityHps':[2],
                   'InnovationHps':[2],
                   'PriceHps':[2]},
```

```
                  index = ['Me'])
#p_parts_list = [e.predict_parts(observation) for e in exp_list]
#p_parts_list[0].plot(p_parts_list[1:], min_max=[-0.1, 1.1])
```

```
p_parts_list = [e.predict_parts(observation) for e in exp_list]
#p_parts_list = [e.predict_parts(observation).result for e in exp_list]
p_parts_list[1]
```

	variable_name	variable_value	variable	cumulative	contribution	sign	position	label
0	intercept		intercept	0.590278	0.590278	1.0	8	RFClassifier: class 2
1	ActivityHps	2.0	ActivityHps = 2.0	0.496012	-0.094266	-1.0	7	RFClassifier: class 2
2	PriceHps:FactorHps	2.0:3.0	PriceHps:FactorHps = 2.0:3.0	0.621419	0.125407	1.0	6	RFClassifier: class 2
3	InnovationHps	2.0	InnovationHps = 2.0	0.561438	-0.059980	-1.0	5	RFClassifier: class 2
4	Education	2.0	Education = 2.0	0.507024	-0.054415	-1.0	4	RFClassifier: class 2
5	Occupation:Gender	2.0:1.0	Occupation:Gender = 2.0:1.0	0.522798	0.015774	1.0	3	RFClassifier: class 2
6	Age	2.0	Age = 2.0	0.517688	-0.005109	-1.0	2	RFClassifier: class 2
7	Status	0.0	Status = 0.0	0.520000	0.002312	1.0	1	RFClassifier: class 2
8			prediction	0.520000	0.520000	1.0	0	RFClassifier: class 2

```
p_parts_list[0].plot(p_parts_list[1:], min_max=[-0.1, 1.1])
```




```
MLdecision_tree(observation)
```

```
acc_random_forest_hp: 100.0
acc_random_forest_gender: 100.0
acc_random_forest_age: 100.0
acc_random_forest_status: 100.0
acc_random_forest_edu: 100.0
```

```
acc_random_forest_occ: 100.0
              precision    recall  f1-score   support

           1       1.00      1.00      1.00        58
           2       1.00      1.00      1.00       245
           3       1.00      1.00      1.00       129

    accuracy                           1.00       432
   macro avg       1.00      1.00      1.00       432
weighted avg       1.00      1.00      1.00       432

('HP2',
 'male',
 '28-35',
 'single',
 'undergraduate',
 'employee',
 2,
 1,
 2,
 0,
 2,
 2,
 array([[0.21, 0.58, 0.21]]))
```

```
pd.concat((p_parts_list[0].result,p_parts_list[1].result,p_parts_list[2].result))
```

	variable_name	variable_value	variable	cumulative	contribution	sign	position	label
0	intercept		intercept	0.160714	0.160714	1.0	9	RFClassifier: class 1
1	ActivityHps	2.0	ActivityHps = 2.0	0.264425	0.103710	1.0	8	RFClassifier: class 1
2	FactorHps	3.0	FactorHps = 3.0	0.222966	-0.041458	-1.0	7	RFClassifier: class 1
3	PriceHps:Gender	2.0:1.0	PriceHps:Gender = 2.0:1.0	0.154573	-0.068393	-1.0	6	RFClassifier: class 1
4	InnovationHps	2.0	InnovationHps = 2.0	0.198006	0.043433	1.0	5	RFClassifier: class 1
5	Status	0.0	Status = 0.0	0.194891	-0.003115	-1.0	4	RFClassifier: class 1
6	Age	2.0	Age = 2.0	0.218413	0.023522	1.0	3	RFClassifier: class 1
7	Occupation	2.0	Occupation = 2.0	0.216270	-0.002143	-1.0	2	RFClassifier: class 1
8	Education	2.0	Education = 2.0	0.220000	0.003730	1.0	1	RFClassifier: class 1
9			prediction	0.220000	0.220000	1.0	0	RFClassifier: class 1
0	intercept		intercept	0.590278	0.590278	1.0	8	RFClassifier: class 2
1	ActivityHps	2.0	ActivityHps = 2.0	0.496012	-0.094266	-1.0	7	RFClassifier: class 2
2	PriceHps:FactorHps	2.0:3.0	PriceHps:FactorHps = 2.0:3.0	0.621419	0.125407	1.0	6	RFClassifier: class 2
3	InnovationHps	2.0	InnovationHps = 2.0	0.561438	-0.059980	-1.0	5	RFClassifier: class 2
4	Education	2.0	Education = 2.0	0.507024	-0.054415	-1.0	4	RFClassifier: class 2
5	Occupation:Gender	2.0:1.0	Occupation:Gender = 2.0:1.0	0.522798	0.015774	1.0	3	RFClassifier: class 2
6	Age	2.0	Age = 2.0	0.517688	-0.005109	-1.0	2	RFClassifier: class 2
7	Status	0.0	Status = 0.0	0.520000	0.002312	1.0	1	RFClassifier: class 2
8			prediction	0.520000	0.520000	1.0	0	RFClassifier: class 2
0	intercept		intercept	0.249008	0.249008	1.0	7	RFClassifier: class 3
1	Education	2.0	Education = 2.0	0.310526	0.061518	1.0	6	RFClassifier: class 3
2	PriceHps:FactorHps	2.0:3.0	PriceHps:FactorHps = 2.0:3.0	0.270635	-0.039891	-1.0	5	RFClassifier: class 3
3	InnovationHps	2.0	InnovationHps = 2.0	0.275129	0.004494	1.0	4	RFClassifier: class 3
4	Age	2.0	Age = 2.0	0.253740	-0.021389	-1.0	3	RFClassifier: class 3
5	Occupation:Gender	2.0:1.0	Occupation:Gender = 2.0:1.0	0.371706	0.117966	1.0	2	RFClassifier: class 3
6	ActivityHps:Status	2.0:0.0	ActivityHps:Status = 2.0:0.0	0.260000	-0.111706	-1.0	1	RFClassifier: class 3
7			prediction	0.260000	0.260000	1.0	0	RFClassifier: class 3

```
p_parts_list[1].result
```

	variable_name	variable_value	variable	cumulative	contribution	sign	position	label
0	intercept		intercept	0.590278	0.590278	1.0	8	RFClassifier: class 2
1	ActivityHps	2.0	ActivityHps = 2.0	0.496012	-0.094266	-1.0	7	RFClassifier: class 2
2	PriceHps:FactorHps	2.0:3.0	PriceHps:FactorHps = 2.0:3.0	0.621419	0.125407	1.0	6	RFClassifier: class 2
3	InnovationHps	2.0	InnovationHps = 2.0	0.561438	-0.059980	-1.0	5	RFClassifier: class 2
4	Education	2.0	Education = 2.0	0.507024	-0.054415	-1.0	4	RFClassifier: class 2
5	Occupation:Gender	2.0:1.0	Occupation:Gender = 2.0:1.0	0.522798	0.015774	1.0	3	RFClassifier: class 2
6	Age	2.0	Age = 2.0	0.517688	-0.005109	-1.0	2	RFClassifier: class 2
7	Status	0.0	Status = 0.0	0.520000	0.002312	1.0	1	RFClassifier: class 2
8			prediction	0.520000	0.520000	1.0	0	RFClassifier: class 2

```
adata = p_parts_list[2].result

adata['contribution'] = round(adata['contribution'],3)
adata
```

	variable_name	variable_value	variable	cumulative	contribution	sign	position	label
0	intercept		intercept	0.249008	0.249	1.0	7	RFClassifier: class 3
1	Education	2.0	Education = 2.0	0.310526	0.062	1.0	6	RFClassifier: class 3
2	PriceHps:FactorHps	2.0:3.0	PriceHps:FactorHps = 2.0:3.0	0.270635	-0.040	-1.0	5	RFClassifier: class 3
3	InnovationHps	2.0	InnovationHps = 2.0	0.275129	0.004	1.0	4	RFClassifier: class 3
4	Age	2.0	Age = 2.0	0.253740	-0.021	-1.0	3	RFClassifier: class 3
5	Occupation:Gender	2.0:1.0	Occupation:Gender = 2.0:1.0	0.371706	0.118	1.0	2	RFClassifier: class 3
6	ActivityHps:Status	2.0:0.0	ActivityHps:Status = 2.0:0.0	0.260000	-0.112	-1.0	1	RFClassifier: class 3
7			prediction	0.260000	0.260	1.0	0	RFClassifier: class 3

Next steps: Generate code with `adata` View recommended plots New interactive sheet

```
import plotly.express as px

def get_explaination(observation):
    X = train_df[observation.columns.values]
    y = train_df["HpAnswer"]
    model = RandomForestClassifier(n_estimators=100)
    model.fit(X, y)
    exp_list = []

    for i in range(len(np.unique(y))):
        # add i parameter to `predict_function` just to do it in a loop
        pf = lambda m, d, i=i: m.predict_proba(d)[:, i]
        e = dx.Explainer(
            model, X,
            y == i,
            predict_function=pf,
            label=f'{i+1}',
            verbose=False
        )
        exp_list += [e]

    p_parts_list = [e.predict_parts(observation) for e in exp_list]
    adata = pd.concat((p_parts_list[0].result,p_parts_list[1].result,p_parts_list[2].result))
    adata['contribution'] = round(adata['contribution'],3)
    pt = adata.loc[adata['variable']=="prediction"]
    pmax = pt['contribution'].max()
    pt = pt.loc[pt['contribution']==pmax]
    htype = pt['label'].iloc[0]

    adata = adata.loc[adata['label']==htype]
    #print(adata)
    fig = go.Figure()
    bcolors = []
    adata['variable_name'].replace("",'prediction', inplace=True)
    for i in range(len(adata['contribution'])):
        if (adata.iloc[i]['contribution'] < 0):
               bcolors.append("red")
        elif(adata.iloc[i]['contribution'] > 0 and adata.iloc[i]['variable_name']!="prediction" \
             and adata.iloc[i]['variable_name']!="intercept"):
               bcolors.append("green")
```

```
        elif(adata.iloc[i]['variable_name']=="prediction"):
               bcolors.append("blue")
        elif(adata.iloc[i]['variable_name']=="intercept"):
               bcolors.append("white")
    fig.add_trace(go.Bar(
        y= adata['variable_name'],
        x=adata['contribution'],
        orientation='h',
        text = adata['contribution'],
        marker=dict(
            color=bcolors,
            #line=dict(color='rgba(246, 78, 139, 1.0)', width=3)
        )
    ))
    fig.update_layout(
        title= f'<b>Explaination: product selection HP{htype}</b>',
        margin=dict(l=0, r=0, t=35, b=10),
        #height=300
    )

    return fig

def get_exresult(observation):

    X = train_df[observation.columns.values]
    y = train_df["HpAnswer"]
    model = RandomForestClassifier(n_estimators=100)
    model.fit(X, y)
    exp_list = []

    for i in range(len(np.unique(y))):
        # add i parameter to `predict_function` just to do it in a loop
        pf = lambda m, d, i=i: m.predict_proba(d)[:, i]
        e = dx.Explainer(
            model, X,
            y == i,
            predict_function=pf,
            label=f'{i+1}',
            verbose=False
        )
        exp_list += [e]

    p_parts_list = [e.predict_parts(observation) for e in exp_list]
    adata2 = pd.concat((p_parts_list[0].result,p_parts_list[1].result,p_parts_list[2].result))
    adata = pd.concat((p_parts_list[0].result,p_parts_list[1].result,p_parts_list[2].result))
    adata['contribution'] = round(adata['contribution'],3)
    pt = adata.loc[adata['variable']=="prediction"]
    pmax = pt['contribution'].max()
    pt = pt.loc[pt['contribution']==pmax]
    htype = pt['label'].iloc[0]
    adata = adata.loc[adata['label']==htype]

    return htype,adata2
```

```
observation2 = pd.DataFrame({'Gender': [1],
                    'Age': [2],
                    'Status': [0],
                    'Education':[2],
                    'Occupation':[2],
                    'FactorHps':[5],
                    'ActivityHps':[2],
                    'InnovationHps':[2],
                    'PriceHps':[2]})
```

```
get_explaination(observation)
```