Install libraries

!pip install shap pyDOE2 anchor-exp
import shap
import pyDOE2
from anchor import anchor_tabular



Requirement already satisfied: cloudpickle in /usr/local/lib/python3.11/dist-Requirement already satisfied: typing-extensions in /usr/local/lib/python3.11, Requirement already satisfied: spacy in /usr/local/lib/python3.11/dist-package Requirement already satisfied: lime in /usr/local/lib/python3.11/dist-packages Requirement already satisfied: llvmlite<0.44,>=0.43.0dev0 in /usr/local/lib/py Requirement already satisfied: joblib>=1.2.0 in /usr/local/lib/python3.11/dist Requirement already satisfied: threadpoolctl>=3.1.0 in /usr/local/lib/python3. Requirement already satisfied: matplotlib in /usr/local/lib/python3.11/dist-page 1.00 Requirement already satisfied: matplotlib in /usr/local/lib/python3. Requirement already satisfied: scikit-image>=0.12 in /usr/local/lib/python3.1. Requirement already satisfied: python-dateutil>=2.8.2 in /usr/local/lib/pythor Requirement already satisfied: pytz>=2020.1 in /usr/local/lib/python3.11/dist-Requirement already satisfied: tzdata>=2022.7 in /usr/local/lib/python3.11/dis Requirement already satisfied: spacy-legacy<3.1.0,>=3.0.11 in /usr/local/lib/r Requirement already satisfied: spacy-loggers<2.0.0,>=1.0.0 in /usr/local/lib/r Requirement already satisfied: murmurhash<1.1.0,>=0.28.0 in /usr/local/lib/pyt Requirement already satisfied: cymem<2.1.0,>=2.0.2 in /usr/local/lib/python3.1 Requirement already satisfied: preshed<3.1.0,>=3.0.2 in /usr/local/lib/python? Requirement already satisfied: thinc<8.4.0,>=8.3.4 in /usr/local/lib/python3.1 Requirement already satisfied: wasabi<1.2.0,>=0.9.1 in /usr/local/lib/python3. Requirement already satisfied: srsly<3.0.0,>=2.4.3 in /usr/local/lib/python3.1 Requirement already satisfied: catalogue<2.1.0,>=2.0.6 in /usr/local/lib/pythc Requirement already satisfied: weasel<0.5.0,>=0.1.0 in /usr/local/lib/python3 Requirement already satisfied: typer<1.0.0,>=0.3.0 in /usr/local/lib/python3.1 Requirement already satisfied: requests<3.0.0,>=2.13.0 in /usr/local/lib/pythc Requirement already satisfied: pydantic!=1.8,!=1.8.1,<3.0.0,>=1.7.4 in /usr/lc Requirement already satisfied: jinja2 in /usr/local/lib/python3.11/dist-packad Requirement already satisfied: setuptools in /usr/local/lib/python3.11/dist-page 1.00 Requirement already satisfied: setuptools in /usr/local/lib/python3. Requirement already satisfied: langcodes<4.0.0,>=3.2.0 in /usr/local/lib/pythc Requirement already satisfied: language-data>=1.2 in /usr/local/lib/python3.1. Requirement already satisfied: annotated-types>=0.6.0 in /usr/local/lib/pythor Requirement already satisfied: pydantic-core==2.33.0 in /usr/local/lib/python? Requirement already satisfied: typing-inspection>=0.4.0 in /usr/local/lib/pyth Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.11/dist-pack Requirement already satisfied: charset-normalizer<4,>=2 in /usr/local/lib/pyth Requirement already satisfied: idna<4,>=2.5 in /usr/local/lib/python3.11/dist-Requirement already satisfied: urllib3<3,>=1.21.1 in /usr/local/lib/python3.1. Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.1. Requirement already satisfied: networkx>=3.0 in /usr/local/lib/python3.11/dist Requirement already satisfied: pillow>=10.1 in /usr/local/lib/python3.11/dist-Requirement already satisfied: imageio!=2.35.0,>=2.33 in /usr/local/lib/pythor

```
Requirement already satisfied: tifffile>=2022.8.12 in /usr/local/lib/python3.1
Requirement already satisfied: lazy-loader>=0.4 in /usr/local/lib/python3.11/c
Requirement already satisfied: blis<1.3.0,>=1.2.0 in /usr/local/lib/python3.1.
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Requirement already satisfied: rich>=10.11.0 in /usr/local/lib/python3.11/dist
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Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.11/dist-
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Requirement already satisfied: markdown-it-py>=2.2.0 in /usr/local/lib/python?
Requirement already satisfied: pygments<3.0.0,>=2.13.0 in /usr/local/lib/pythc
Requirement already satisfied: wrapt in /usr/local/lib/python3.11/dist-package
```

```
import pandas as pd
import sklearn
import lime
from lime import lime_tabular

import xgboost as xgb
from sklearn.model_selection import train_test_split
import lightgbm as lgb
```

Tutorial

Set up tutorial examples

Start by training the "should you bring an umbrella?" model

```
preX = pd.read_csv("Umbrella.csv")
preX = preX.sample(frac=1)
X_display = preX.iloc[:,:-1]
y_display = preX.iloc[:,-1]

PRECIPITATION = {
    "none": 0,
    "drizzle": 1,
```

```
"rain": 2,
    "snow": 3,
    "sleet": 4,
    "hail": 5
}
y = y_display
X = X_{display}
X = X.replace({"Precipitation":PRECIPITATION})
X train = X.iloc[:300]
y_{train} = y_{iloc}[:300]
X_{\text{test}} = X_{\text{iloc}}[300:]
y_{\text{test}} = y_{\text{iloc}}[300:]
d_train = lgb.Dataset(X_train, label=y_train)
d_test = lgb.Dataset(X_test, label=y_test)
params = {
    "max_bin": 512,
    "learning_rate": 0.05,
    "boosting_type": "gbdt",
    "objective": "binary",
    "metric": "binary_logloss",
    "num leaves": 10,
    "verbose": -1,
    "min_data": 100,
    "boost_from_average": True,
    "keep_training_booster": True
}
#model = lgb.train(params, d_train, 10000, valid_sets=[d_test]) #early_stopping_re
model = lgb.LGBMClassifier(max_bin= 512,
    learning rate= 0.05,
    boosting_type= "gbdt",
    objective= "binary",
    metric= "binary_logloss",
    num_leaves= 10,
    verbose= -1,
    min_data= 100,
    boost_from_average= True)
model.fit(X_train, y_train)
```

```
\overline{\Sigma}
```

<ipython-input-160-0ae06d0dfa92>:17: FutureWarning: Downcasting behavior in `r
 X = X.replace({"Precipitation":PRECIPITATION})

```
LGBMClassifier

LGBMClassifier(boost_from_average=True, learning_rate=0.05, max_bin=512, metric='binary_logloss', min_data=100, num_leaves=10, objective='binary', verbose=-1)
```

Find the location of one of the two tutorial examples

```
print(X.loc[(X['Precipitation'] == 5) & (X['Temperature'] == 23) & (X['Wind(mph)'
print(X.loc[(X['Precipitation'] == 0) & (X['Temperature'] == 70) & (X['Wind(mph)'
theloc = X.index.get_loc(330)
Precipitation Temperature Wind(mph)
```

```
Precipitation Temperature Wind(mph)
330 5 23 10
Precipitation Temperature Wind(mph)
96 0 70 30
```

Generate a tutorial explanation

```
from anchor import anchor_tabular
explainer = anchor_tabular.AnchorTabularExplainer(
    ["YES","NO"],
    [ "Precipitation", "Temperature", "Wind"],
    X.to_numpy(),
    {0:["None","drizzle", "rain", "snow", "sleet", "hail"]}
)
```

```
print('Prediction: ', explainer.class_names[model.predict(X.iloc[theloc,:].to_num]
exp = explainer.explain_instance(X.iloc[theloc,:].to_numpy(), model.predict, threexp.show_in_notebook()
```

```
/usr/local/lib/python3.11/dist-packages/sklearn/utils/deprecation.py:151: FutureWarning: 'f warnings.warn(
<ipython-input-163-2c8ae0164223>:1: DeprecationWarning: In future, it will be an error for print('Prediction: ', explainer.class_names[model.predict(X.iloc[theloc,:].to_numpy().res /usr/local/lib/python3.11/dist-packages/sklearn/utils/deprecation.py:151: FutureWarning: 'f warnings.warn(
/usr/local/lib/python3.11/dist-packages/sklearn/utils/deprecation.py:151: FutureWarning: 'f warnings.warn(
/usr/local/lib/python3.11/dist-packages/sklearn/utils/deprecation.py:151: FutureWarning: 'f
```

warnings.warn(/usr/local/lib/python3.11/dist-packages/sklearn/utils/deprecation.py:151: FutureWarning: 'f warnings.warn(Prediction: NO /usr/local/lib/python3.11/dist-packages/sklearn/utils/deprecation.py:151: FutureWarning: 'f warnings.warn(



Precipitation = hail

Temperature <= 30.00

7.00 < Wind <= 15.00

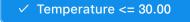
A.I. predi...



YES

Explanation of A.I. prediction

If ALL of these are true:



The A.I. will predict YES 100.0% of the time

Precipitation = drizzle
Temperature <= 30.00
7.00 < Wind <= 15.00</pre>

Examples where the A.I. agent DOES NOT predict YES

Could not find any Examples

Loan Instances

Edit and prepare the dataset

```
# load dataset
X,y = shap.datasets.adult()
X_display,y_display = shap.datasets.adult(display=True)
EDUCATION_NUM = {
    16.0: "Doctorate",
    15.0: "Prof. School",
    14.0: "Masters",
    13.0: "Bachelors",
    12.0: "Some College",
    11.0: "Associate", #Assoc-acdm
    10.0: "Vocational", #Assoc-voc
    9.0: "HS grad",
    8.0: "12th",
    7.0: "11th",
    6.0: "10th",
    5.0: "9th",
    4.0: "7th-8th",
    3.0: "5th-6th",
    2.0: "1st-4th",
    1.0: "Preschool"
}
OCCUPATION NUM = {
    "Tech-support": "Tech Support",
    "Craft-repair": "Craft/Repair",
    "Other-service": "Other Service",
    "Sales": "Sales",
    "Exec-managerial": "Exec. Managerial",
    "Prof-specialty": "Prof. Specialty",
    "Handlers-cleaners": "Handler/Cleaner",
    "Machine-op-inspct": "Machine Op. Inspector",
    "Adm-clerical": "Admin. Clerical",
    "Farming-fishing": "Farming/Fishing",
    "Transport-moving": "Transport/Moving",
    "Priv-house-serv": "Private House Service",
```

Train the model

```
params = {
    "max_bin": 512,
    "learning_rate": 0.05,
    "boosting_type": "gbdt",
    "objective": "binary",
    "metric": "binary_logloss",
    "num leaves": 10,
    "verbose": -1,
    "min_data": 100,
    'objective': 'multi:softprob',
    "boost_from_average": True
}
params_xgb={
    'base score':0.5,
    'learning rate':0.05,
    'max_depth':5,
    'min_child_weight':100,
    'n_estimators':200,
    'num class': 2,
    'nthread':-1,
    'objective': 'multi:softprob',
    'seed':2018,
    'eval metric': 'auc'
}
model = lgb.LGBMClassifier(max_bin= 512,
    learning rate= 0.05,
    boosting_type= "gbdt",
    objective= "binary",
    metric= "binary logloss",
    num leaves= 10,
    verbose= -1,
    min_data= 100,
    boost_from_average= True)
model.fit(X_train, y_train)
```

$\overline{\Rightarrow}$

LGBMClassifier

LGBMClassifier(boost_from_average=True, learning_rate=0.05, max_bin=512, metric='binary_logloss', min_data=100, num_leaves=10, objective='binary', verbose=-1)

Data locations of our 7 instances

```
#val = 610 # Woman Side-by-side
#val = 11116 # Man Side-by-side
#val = 32353 # Man 3
#val = 217 # Man 2
#val = 15040 # Man 1
#val = 32429 # Woman 3
val = 32556 # Woman 2
#val = 91#91 # Woman 1
theloc = val
```

Run Anchors, and create an explanation

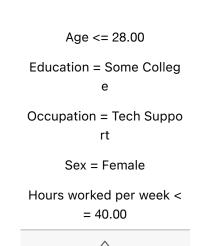
```
explainer = anchor_tabular.AnchorTabularExplainer(
    ["NO", "YES"],
    [ "Age", "Education", "Occupation", "Sex", "Hours worked per week"],
   X_test.to_numpy(),
    {1:["None","Preschool", "1st-4th", "5th-6th", "7th-8th", "9th", "10th", "11th"
exp = explainer.explain_instance(X.iloc[theloc,:].to_numpy(), model.predict, thre
    /usr/local/lib/python3.11/dist-packages/sklearn/utils/deprecation.py:151: Futu
      warnings.warn(
    /usr/local/lib/python3.11/dist-packages/sklearn/utils/deprecation.py:151: Futi
      warnings.warn(
    /usr/local/lib/python3.11/dist-packages/sklearn/utils/deprecation.py:151: Futu
      warnings.warn(
```

Result

exp.show_in_notebook()



Example



A.I. predi...



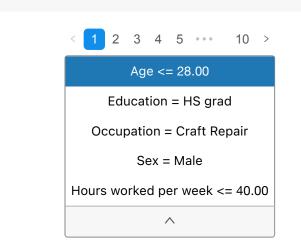
Explanation of A.I. prediction

If ALL of these are true:

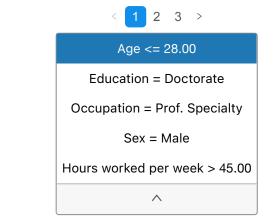


The A.I. will predict NO **98.5%** of the time

Examples where the A.I. agent predicts NO



Examples where the A.I. agent DOES NOT predict NO



exp.save_to_file("outputwomantwo.html")