Homework 2: Trees and Calibration

Instructions

Please push the .ipynb, .py, and .pdf to Github Classroom prior to the deadline. Please include your UNI as well.

Make sure to use the dataset that we provide in CourseWorks/Classroom.

There are a lot of applied questions based on the code results. Please make sure to answer them all. These are primarily to test your understanding of the results your code generate (similar to any Data Science/ML case study interviews).

Due Date : 10/14 (October 14th), 11:59 PM EST

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The Dataset

Acknowledgements

Big Thanks to https://www.superdatascience.com/pages/deep-learning

Banner Photo by Sharon McCutcheon on Unsplash

Description

This data set contains details of a bank's customers and the target variable is a binary variable reflecting the fact whether the customer left the bank (closed his account) or he continues to be a customer.

In [1]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
```

Question 1: Decision Trees

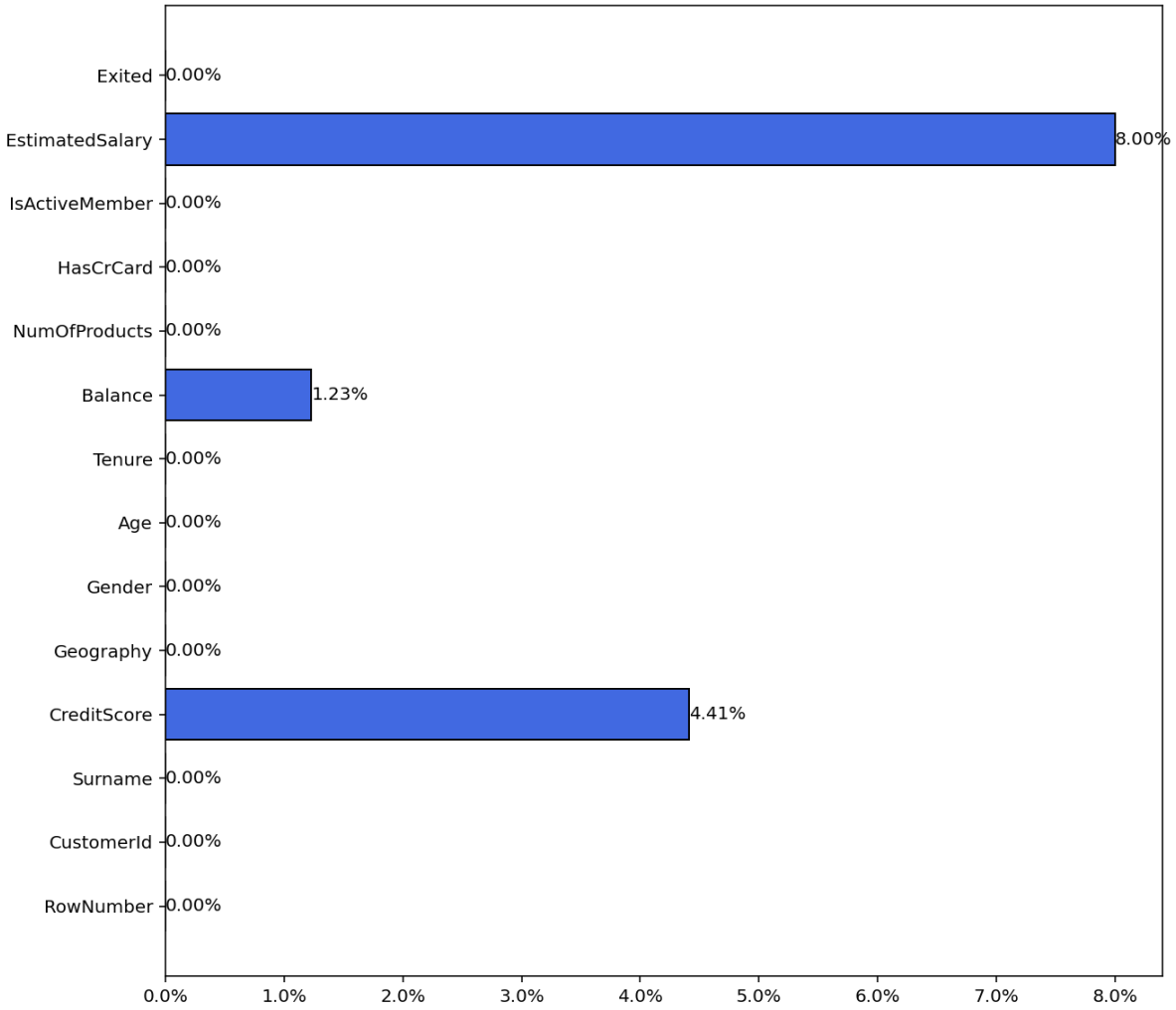
1.1: Load the provided dataset

In [2]:
```
## YOUR CODE HERE
bank = pd.read_csv("HW2_dataset.csv")
```

1.2: Plot % of missing values in each column. Would you consider dropping any

columns? Assuming we want to train a decision tree, would you consider imputing the missing values? If not, why? (Remove the columns that you consider dropping)

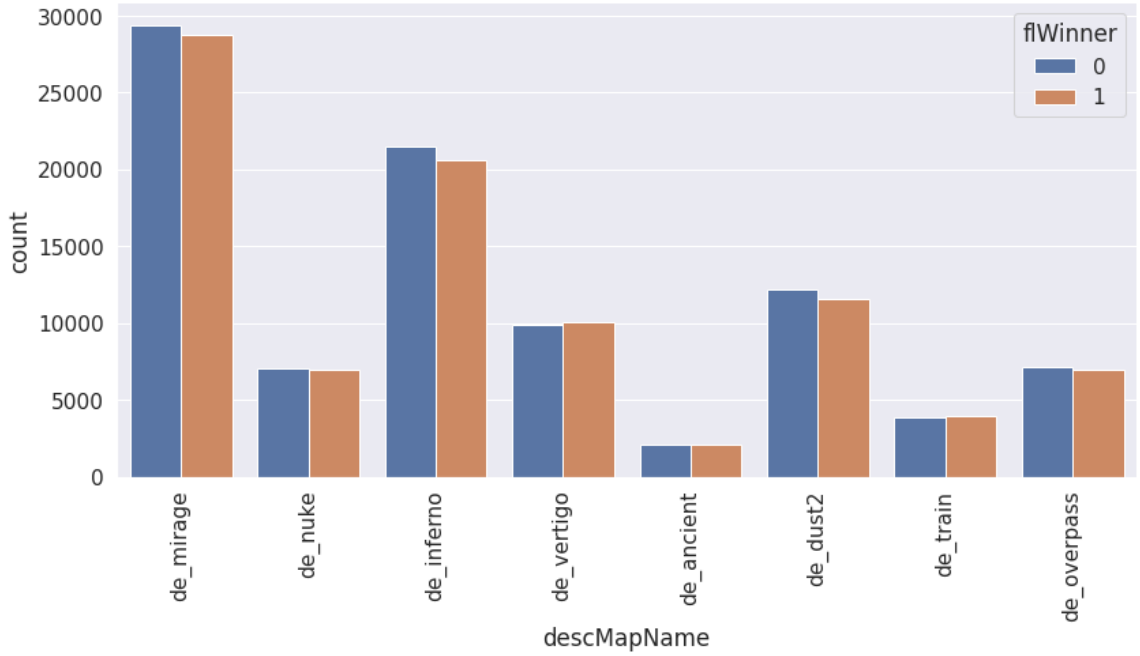
In [3]:
```
## YOUR CODE HERE
import matplotlib.ticker as mtick
fig, ax = plt.subplots(figsize=(10,10),dpi=144)
label = bank.columns,bank.isnull().sum()*100/len(bank)
bar = ax.barh(bank.columns,bank.isnull().sum()*100/len(bank), color='royalbl
ax.xaxis.set_major_formatter(mtick.PercentFormatter())
ax.bar_label(bar,labels=['%.2f%%'%l for l in label[1][:]])
plt.show()
print("I will drop the RowNumber, CustomerId, and surname columns because th
or not. ")
```




```
I will drop the RowNumber, CustomerId, and surname columns because they have
no relationship with exiting or not.
```

1.3: Plot side-by-side bars of class distribtuion for each category for the categorical feature and the target categories.

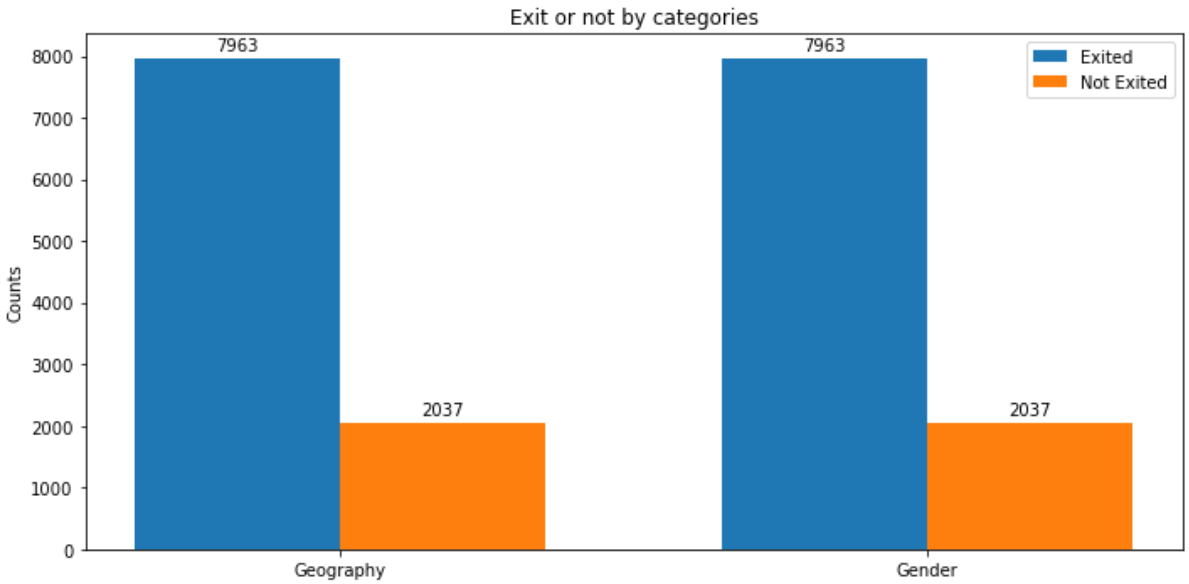
Clarification with Example below : Here `flWinner` is the Target Variable and `descMapName` is a categorical feature. You are required to make such side-by-side bar plot for each categorical feature with repect to it's class distribution with the target feature for our dataset.



In [4]:
```
## YOUR CODE HERE
categorical = ['Geography','Gender']
exit = bank[['Geography','Gender','Exited']].groupby('Exited').count()
fig, ax = plt.subplots(figsize=(10,5))
label = exit.columns
ind = np.arange(len(exit.columns))  # the x locations for the groups
width = 0.35       # the width of the bars
exited = ax.bar(ind-width/2, np.array(exit[0:1]).reshape(2,),width, label='E
not_exited = ax.bar(ind+width/2, np.array(exit[1:2]).reshape(2,), width, lab

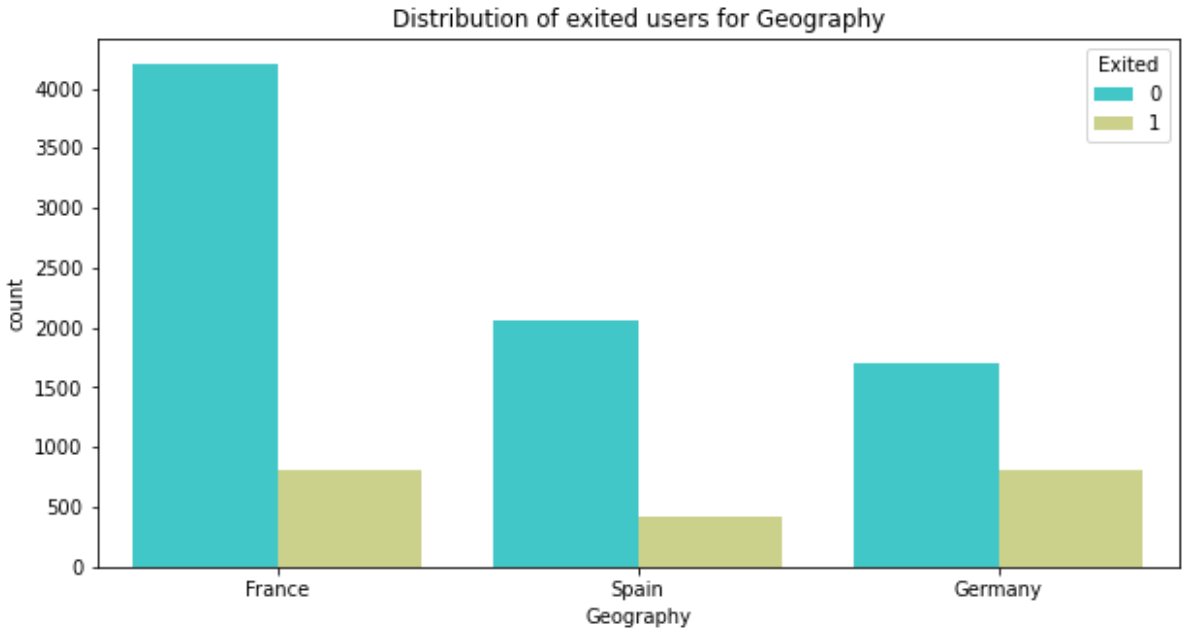
ax.set_ylabel('Counts')
ax.set_title('Exit or not by categories')
ax.set_xticks(ind, label)
ax.legend()

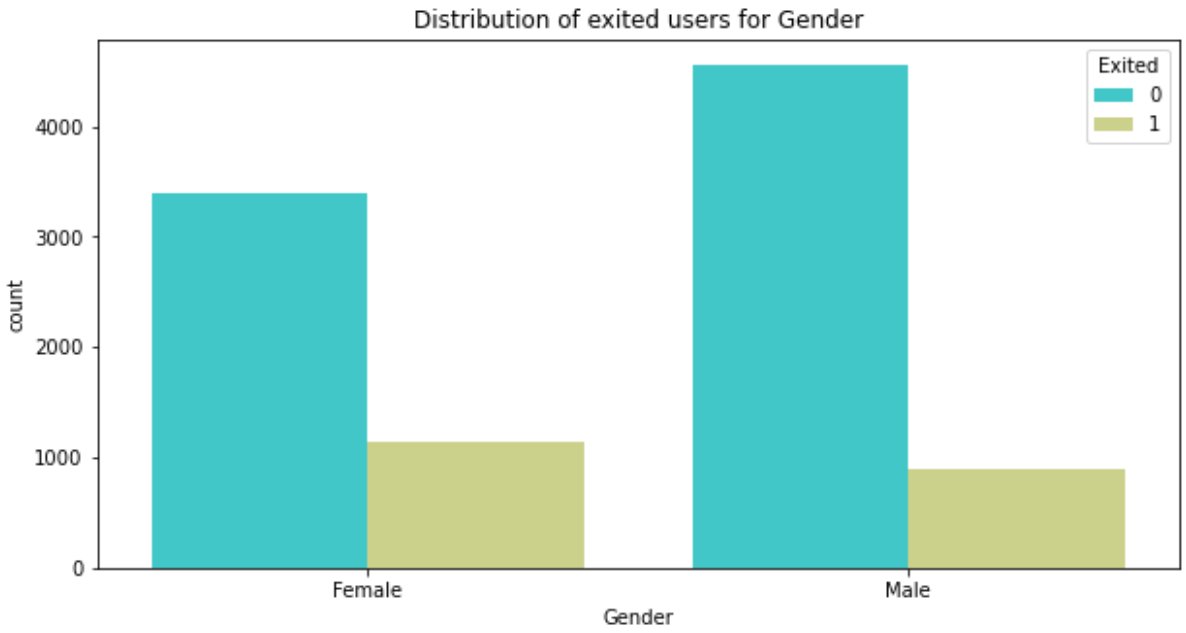
ax.bar_label(exited, padding=3)
ax.bar_label(not_exited, padding=3)
fig.tight_layout()
plt.show()
```



In [5]:
```
from sklearn.impute import SimpleImputer
imp_mean = SimpleImputer(missing_values=np.nan, strategy='mean')
imp_mean.fit(bank[['CreditScore','Balance','EstimatedSalary']])
```

```
bank[['CreditScore','Balance','EstimatedSalary']]= imp_mean.transform(bank[[
for c in categorical:
    plt.figure(figsize=(10,5))
    sns.countplot(x=c,data=bank,palette='rainbow',hue='Exited')
    plt.title(f"Distribution of exited users for {c}")
```





1.4: Split the data into development and test datasets. Which splitting methodology did you choose and why?

In [6]:
```
## YOUR CODE HERE
from sklearn.model_selection import train_test_split
bank_X = bank.drop(columns=['RowNumber','CustomerId','Surname','Exited'])
bank_y = bank['Exited']
bank_X_dev, bank_X_test, bank_y_dev, bank_y_test = train_test_split(bank_X,
bank_X_train, bank_X_val, bank_y_train, bank_y_val = train_test_split(bank_X
print("I choose stratified spliting because the ration of target value is im
```

```
I choose stratified spliting because the ration of target value is imbalance
d.
```

1.5: Preprocess the data (Handle the Categorical Variable). Do we need to apply scaling? Briefly Justify

In [7]:
```
## YOUR CODE HERE
# from sklearn.preprocessing import OrdinalEncoder
# oe = OrdinalEncoder()
# for c in categorical:
#     bank_X_train[c] = oe.fit_transform(bank_X_train[c].to_numpy().reshape(
#     bank_X_val[c] = oe.fit_transform(bank_X_val[c].to_numpy().reshape(-1,1
#     bank_X_test[c] = oe.fit_transform(bank_X_test[c].to_numpy().reshape(-1

# bank_X_train

from sklearn.preprocessing import OneHotEncoder
ohe_geo = OneHotEncoder()
ohe_gen = OneHotEncoder()

geo_transformed_train = ohe_geo.fit_transform(bank_X_train[["Geography"]])
bank_X_train[["France","Spain","Germany"]] = geo_transformed_train.toarray()
gen_transformed_train = ohe_gen.fit_transform(bank_X_train[["Gender"]])
bank_X_train[["Female","Male"]] = gen_transformed_train.toarray()
bank_X_train.drop(columns = ["Geography","Gender"],axis=1,inplace = True)

geo_transformed_val = ohe_geo.fit_transform(bank_X_val[["Geography"]])
bank_X_val[["France","Spain","Germany"]] = geo_transformed_val.toarray()
gen_transformed_val = ohe_gen.fit_transform(bank_X_val[["Gender"]])
bank_X_val[["Female","Male"]] = gen_transformed_val.toarray()
bank_X_val.drop(columns = ["Geography","Gender"],axis=1,inplace = True)

geo_transformed_test = ohe_geo.fit_transform(bank_X_test[["Geography"]])
bank_X_test[["France","Spain","Germany"]] = geo_transformed_test.toarray()
gen_transformed_test = ohe_gen.fit_transform(bank_X_test[["Gender"]])
bank_X_test[["Female","Male"]] = gen_transformed_test.toarray()
bank_X_test.drop(columns = ["Geography","Gender"],axis=1,inplace = True)

print("We do not fneed to apply scaling because the decision tree will split
with a certain line. Even after scaling, the separted porportion is still th
```

```
We do not fneed to apply scaling because the decision tree will split the da
ta in to different sections with a certain line. Even after scaling, the sep
arted porportion is still the same, so there is no need to scale.
```

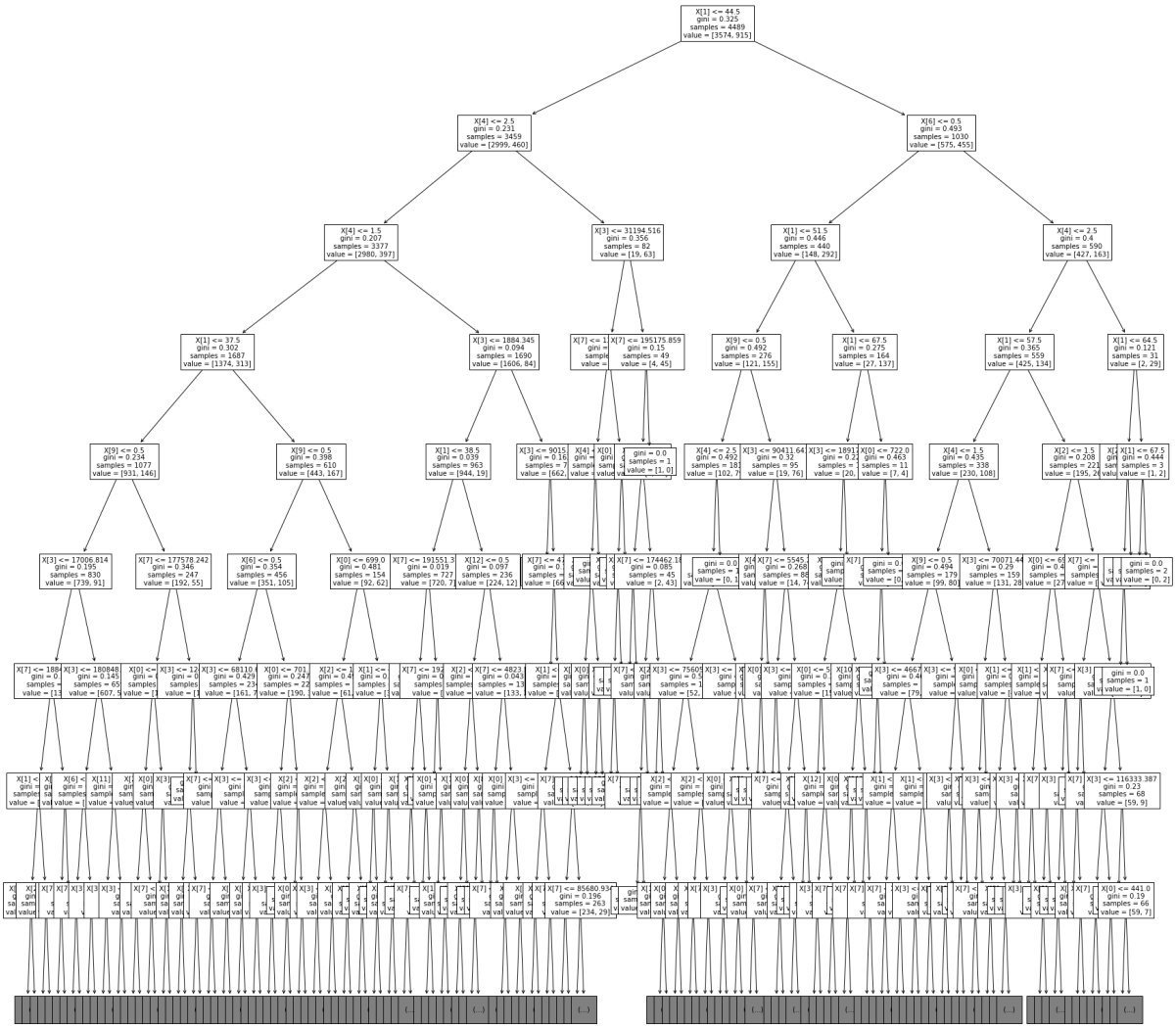
1.6: Fit a Decision Tree on the development data until all leaves are pure. What is the performance of the tree on the development set and test set? Provide metrics you believe are relevant and briefly justify.

In [8]:
```
## YOUR CODE HERE
from sklearn.tree import DecisionTreeClassifier
from sklearn.metrics import accuracy_score
from sklearn.metrics import recall_score
from sklearn.metrics import precision_score
from sklearn.metrics import f1_score
dtc = DecisionTreeClassifier()
dtc.fit(bank_X_train,bank_y_train)
bank_y_val_pred = dtc.predict(bank_X_val)
bank_y_test_pred = dtc.predict(bank_X_test)
print(f"For the development set the recall score is {recall_score(bank_y_val
the precision score is {precision_score(bank_y_val,bank_y_val_pred,pos_label
the F1-Score is {f1_score(bank_y_val,bank_y_val_pred,pos_label=1)}.")
print(f"For the test set the recall score is {recall_score(bank_y_test,bank_
the precision score is {precision_score(bank_y_test,bank_y_test_pred,pos_lab
the F1-Score is {f1_score(bank_y_test,bank_y_test_pred,pos_label=1)}.")
print("Precision, Recall, and F1 are metrics relevant to the decision tree b
```

```
For the development set the recall score is 0.49777777777777776, the precisi
on score is 0.4890829694323144, the F1-Score is 0.4933920704845815.
For the test set the recall score is 0.49851190476190477, the precision scor
e is 0.475177304964539, the F1-Score is 0.486564996368918.
Precision, Recall, and F1 are metrics relevant to the decision tree bceause
they are better for imbalance datasets.
```

1.7: Visualize the trained tree until the max_depth 8

In [9]:
```
## YOUR CODE HERE
from sklearn import tree
plt.figure(figsize=(30,30))
tree.plot_tree(dtc,max_depth=8, fontsize=10)
plt.savefig('tree_high_dpi', dpi=144)
```



1.8: Prune the tree using one of the techniques discussed in class and evaluate the performance

In [10]:
```
## YOUR CODE HERE
# cost complexity pruning
cc = dtc.cost_complexity_pruning_path(bank_X_train,bank_y_train)
alphas = cc.ccp_alphas
impurities = cc.impurities
max_a = alphas[0]
accuracy = -1
for a in alphas:
    dt = DecisionTreeClassifier(random_state=0,ccp_alpha = a)
```

```
    dt.fit(bank_X_train,bank_y_train)
    score = precision_score(bank_y_val,dt.predict(bank_X_val))
    if accuracy < score:
        accuracy = score
        max_a = a
dt_best = DecisionTreeClassifier(ccp_alpha = max_a)
dt_best.fit(bank_X_train,bank_y_train)
print(f"The precision score on the development set is {precision_score(bank_
print(f"The precision score on the test set is {precision_score(bank_y_test,
print("The precision score for the development set and test set after prunin
```

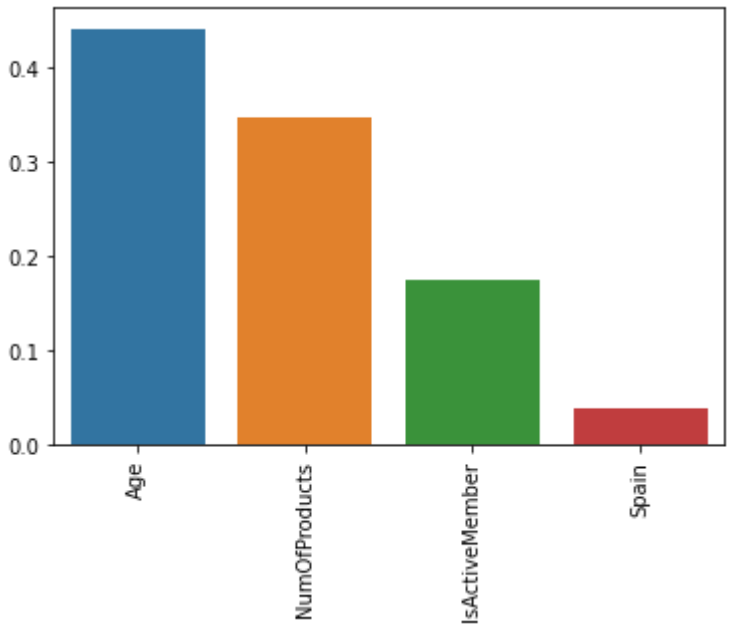
```
The precision score on the development set is 0.8074866310160428.
The precision score on the test set is 0.8237410071942446.
The precision score for the development set and test set after pruning is hi
gher than before.
```

```
/Users/alanzhu/opt/anaconda3/lib/python3.9/site-packages/sklearn/metrics/_cl
assification.py:1318: UndefinedMetricWarning: Precision is ill-defined and b
eing set to 0.0 due to no predicted samples. Use `zero_division` parameter t
o control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

1.9: List the top 3 most important features for this trained tree? How would you justify these features being the most important?

In [11]:
```
## YOUR CODE HERE
feat_imps = list(zip(bank_X_train.columns,dt_best.feature_importances_))
feats,imps = zip(*(sorted(list(filter(lambda x:x[1]!=0,feat_imps)),key=lambd
ax = sns.barplot(list(feats),list(imps))
ax.tick_params(axis='x',rotation=90)
plt.show()
print("The top 3 most important features are Age, NumofProducts, IsActivemem
```

```
/Users/alanzhu/opt/anaconda3/lib/python3.9/site-packages/seaborn/_decorator
s.py:36: FutureWarning: Pass the following variables as keyword args: x, y.
From version 0.12, the only valid positional argument will be `data`, and pa
ssing other arguments without an explicit keyword will result in an error or
misinterpretation.
  warnings.warn(
```




```
The top 3 most important features are Age, NumofProducts, IsActivemembet.
```

Question 2: Random Forests

2.1: Train a Random Forest model on the development dataset using RandomForestClassifier class in sklearn. Use the default parameters. Evaluate the performance of the model on test dataset. Does this perform better than Decision Tree on the test dataset (compare to results in Q 1.6)?

In [12]:
```
## YOUR CODE HERE
from sklearn.ensemble import RandomForestClassifier
rfc = RandomForestClassifier()
rfc.fit(bank_X_train,bank_y_train)
rfc_predict = rfc.predict(bank_X_test)
print(f"The precision score on the test set is {precision_score(bank_y_test,
print(f"The score is higher than in 1.6 for test set which is {precision_sco
```

```
The precision score on the test set is 0.7603092783505154.
The score is higher than in 1.6 for test set which is 0.475177304964539.
```

2.2: Does all trees in the trained random forest model have pure leaves? How would you verify this?

In [13]:
```
## YOUR CODE HERE
# rfc.get_params()["min_samples_split"]==2 and rfc.get_params()["max_depth"]
pure = True
for i in range(len(rfc.estimators_)):

    n_nodes = rfc.estimators_[i].tree_.node_count
    children_left = rfc.estimators_[i].tree_.children_left
    children_right = rfc.estimators_[i].tree_.children_right
    impurity = rfc.estimators_[i].tree_.impurity

    node_depth = np.zeros(shape=n_nodes, dtype=np.int64)
    is_leaves = np.zeros(shape=n_nodes, dtype=bool)
    stack = [(0, 0)]
    while len(stack) > 0:
        node_id, depth = stack.pop()
        node_depth[node_id] = depth
        is_split_node = children_left[node_id] != children_right[node_id]
        if is_split_node:
            stack.append((children_left[node_id], depth + 1))
            stack.append((children_right[node_id], depth + 1))
        else:
            is_leaves[node_id] = True
            if (impurity[node_id]!=0):
                pure = False
                break

print(pure)
print("All trees in the trained random forest model have pure leaves. I iter
of every tree in the forst and check their impurity. If the impurity is not
a non-zero impurity implies the leave has more than one category.")
```

```
True
All trees in the trained random forest model have pure leaves. I iterate thr
ough every leave of every tree in the forst and check their impurity. If the
impurity is not equal to 0, the leaf is not pure, since a non-zero impurity
implies the leave has more than one category.
```

2.3: Assume you want to improve the performance of this model. Also, assume that you had to pick two hyperparameters that you could tune to improve its performance. Which hyperparameters would you choose and why?

In [14]:
```
## YOUR ANSWER HERE
```

```
print("I would choose n_estimators and max_depth. The n_estimators represent
Generally, the more trees in the forest, the more accurate the model is. A s
while a tall tree may be overfitting. Thus, I would choose max_depth to find
```

```
I would choose n_estimators and max_depth. The n_estimators represents the n
umber of trees in the forest. Generally, the more trees in the forest, the m
ore accurate the model is. A short tree may be not accurate while a tall tre
e may be overfitting. Thus, I would choose max_depth to find the optimal hei
ght for the tree.
```

2.4: Now, assume you had to choose up to 5 different values (each) for these two hyperparameters. How would you choose these values that could potentially give you a performance lift?

In [15]:
```
## YOUR ANSWER HERE
print(f"For n_estimators, I will choose 200, 300, 400, 500, and 600. For max
As the value of n_estimators increases and the other remains the same, the p
The default n_estimator is 100. I would like to increase the number.\
The default of max_depth is None, which sets no limits on the tree. The dept
is {dtc.tree_.max_depth} in 1.6. I believe the range of depth should be arou
```

```
For n_estimators, I will choose 200, 300, 400, 500, and 600. For max_depth,
I choose 10, 15, 20, 25, and 30. As the value of n_estimators increases and
the other remains the same, the performance should be better. The default n_
estimator is 100. I would like to increase the number.The default of max_dep
th is None, which sets no limits on the tree. The depth of the decision tree
is 29 in 1.6. I believe the range of depth should be around or lower than th
is number.
```

2.5: Perform model selection using the chosen values for the hyperparameters. Use cross-validation for finding the optimal hyperparameters. Report on the optimal hyperparameters. Estimate the performance of the optimal model (model trained with optimal hyperparameters) on test dataset? Has the performance improved over your plain-vanilla random forest model trained in Q2.1?

In [16]:
```
## YOUR CODE HERE
from sklearn.model_selection import cross_val_score
ns = [200,300,400,500,600]
depths = [10,15,20,25,30]
scores = []
for i in range(5):
    rfc_choose = RandomForestClassifier(n_estimators=ns[i], max_depth = dept
    rfc_choose.fit(bank_X_train,bank_y_train)
    score = cross_val_score(rfc_choose,bank_X_train,bank_y_train,cv=5)
    scores.append(np.mean(score))
best_n = ns[np.argmax(scores)]
best_depth = depths[np.argmax(scores)]
best_rfc = RandomForestClassifier(n_estimators=best_n, max_depth = best_dept
best_rfc.fit(bank_X_train,bank_y_train)
print(f"The score of best performace is {np.max(scores)} \
with n_estimators= {best_n} and max_depth = {best_depth}. The performance is
```

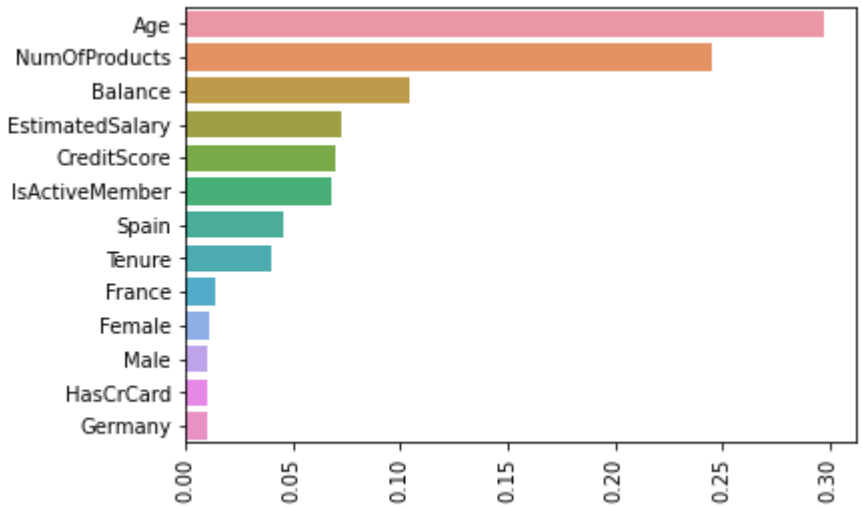
```
The score of best performace is 0.8576494774713037 with n_estimators= 300 an
d max_depth = 15. The performance is better than in Q2.1
```

2.6: Can you find the top 3 most important features from the model trained in Q2.5? How do these features compare to the important features that you found from Q1.9? If they differ, which feature set makes more sense?

In [17]:
```
## YOUR CODE HERE
best_rfc = RandomForestClassifier(n_estimators=best_n,max_depth = 8)
```

```
best_rfc.fit(bank_X_train,bank_y_train)
feature_impors = list(zip(bank_X_train.columns,best_rfc.feature_importances_
feats, imps = zip(*(sorted(list(filter(lambda x:x[1]!=0,feature_impors)),key
ax = sns.barplot(list(imps),list(feats))
ax.tick_params(axis='x',rotation=90)
plt.show()
print("Age, NumofProducts, and Balance are the top 3 most important features
isActivement is replaced by Balance. I think Balance makes more sense becaus
higher than in Q1.9.")
```

```
/Users/alanzhu/opt/anaconda3/lib/python3.9/site-packages/seaborn/_decorator
s.py:36: FutureWarning: Pass the following variables as keyword args: x, y.
From version 0.12, the only valid positional argument will be `data`, and pa
ssing other arguments without an explicit keyword will result in an error or
misinterpretation.
  warnings.warn(
```




```
Age, NumofProducts, and Balance are the top 3 most important features. The d
ifference compare to Q2.5 is that isActivement is replaced by Balance. I thi
nk Balance makes more sense because the performance of model in Q2.5 is high
er than in Q1.9.
```

Question 3: Gradient Boosted Trees

3.1: Choose three hyperparameters to tune GradientBoostingClassifier and HistGradientBoostingClassifier on the development dataset using 5-fold cross validation. Report on the time taken to do model selection for both the models. Also, report the performance of the test dataset from the optimal models.

In [18]:
```
## YOUR CODE HERE
from sklearn.ensemble import GradientBoostingClassifier
from sklearn.ensemble import HistGradientBoostingClassifier
from datetime import datetime
ns = [100,200,300,400,500]
max_iters = [100,200,300,400,500]
depths = [8,9,10,11,12]
learning_rates = [0.1,0.11,0.12,0.13,0.14]
gbr_scores = []

gbr_start = datetime.timestamp(datetime.now())
for i in range(5):
    gbr = GradientBoostingClassifier(n_estimators=ns[i], max_depth = depths[
    gbr.fit(bank_X_train,bank_y_train)
    gbr_score = cross_val_score(gbr,bank_X_train,bank_y_train,cv=5)
    gbr_scores.append(np.mean(gbr_score))
gbr_end = datetime.timestamp(datetime.now())
```

```
hgbc_scores = []
hgbc_start = datetime.timestamp(datetime.now())
for i in range(5):
    hgbc = HistGradientBoostingClassifier(max_iter=max_iters[i], max_depth =
    hgbc.fit(bank_X_train,bank_y_train)
    hgbc_score = cross_val_score(hgbc,bank_X_train,bank_y_train,cv=5)
    hgbc_scores.append(np.mean(hgbc_score))
hgbc_end = datetime.timestamp(datetime.now())



gbr_best_score = np.max(gbr_scores)
hgbc_best_score = np.max(hgbc_scores)
gbr_time = datetime.fromtimestamp(gbr_end)-datetime.fromtimestamp(gbr_start)
hgbc_time = datetime.fromtimestamp(hgbc_end)-datetime.fromtimestamp(hgbc_sta
print(f"The performance of gradient boosting is {gbr_best_score} spending {g
print(f"The performance of hist gradient boosting is {hgbc_best_score} spend
```

```
The performance of gradient boosting is 0.845620516793171 spending 147.24959
seconds
The performance of hist gradient boosting is 0.8487383085911215 spending 30.
206573 seconds
```

3.2: Train an XGBoost model by tuning 3 hyperparameters using 10 fold cross-validation. Compare the performance of the trained XGBoost model on the test dataset against the performances obtained from 3.1

In [19]:
```
## YOUR CODE HERE
from xgboost import XGBClassifier
import warnings
warnings.filterwarnings('ignore')
ns = [100,200,300,400,500,600,700,800,900,1000]
depths = [3,4,6,7,8,9,10,11,12,13]
learning_rates = [0.1,0.11,0.12,0.13,0.14,0.15,0.16,0.17,0.18,0.19]
xgb_scores = []
xgb_start = datetime.timestamp(datetime.now())

for i in range(10):
    xgb = XGBClassifier(n_estimators=ns[i], max_depth = depths[i],learning_r
    xgb.fit(bank_X_train,bank_y_train)
    xgb_score = cross_val_score(xgb,bank_X_train,bank_y_train,cv=10)
    xgb_scores.append(np.mean(xgb_score))
xgb_end = datetime.timestamp(datetime.now())
xgb_time = datetime.fromtimestamp(xgb_end)-datetime.fromtimestamp(xgb_start)

xgb_best_score = np.max(xgb_scores)
print(f"The performance of xgboosting is {xgb_best_score} spending {xgb_time
The xgboosting has higher score compare to 3.1 but spending more time.")
```

```
[20:52:27] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
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/Users/alanzhu/opt/anaconda3/lib/python3.9/site-packages/xgboost/compat.py:3
6: FutureWarning: pandas.Int64Index is deprecated and will be removed from p
andas in a future version. Use pandas.Index with the appropriate dtype inste
ad.
  from pandas import MultiIndex, Int64Index
```

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[20:52:27] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
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[20:52:29] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
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eval_metric if you'd like to restore the old behavior.
[20:52:30] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
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tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
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[20:52:31] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
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[20:52:31] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
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tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
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[20:52:32] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
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[20:52:36] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
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Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
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[20:52:38] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
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[20:52:40] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
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[20:52:41] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
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[20:52:42] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
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[20:52:43] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
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[20:52:43] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
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[20:52:45] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
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[20:52:46] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
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[20:52:47] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
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[20:52:48] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
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[20:52:50] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
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[20:52:51] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
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[20:52:54] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
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tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
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[20:52:57] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
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[20:52:59] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
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[20:53:00] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
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[20:53:02] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
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[20:53:04] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
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[20:53:06] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
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[20:53:07] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
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[20:53:09] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
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[20:53:11] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
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btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
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[20:53:14] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
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[20:53:15] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:53:18] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:53:20] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:53:22] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:53:24] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:53:26] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:53:28] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:53:30] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:53:33] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:53:35] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
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[20:53:37] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
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tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:53:39] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:53:41] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:53:44] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:53:46] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:53:48] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:53:50] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:53:53] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:53:55] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:53:58] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:54:00] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
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[20:54:03] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:54:05] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
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eval_metric if you'd like to restore the old behavior.
[20:54:08] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:54:10] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:54:13] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:54:15] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:54:18] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
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tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
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[20:54:20] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:54:23] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:54:26] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:54:29] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:54:31] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
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btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:54:38] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:54:41] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
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tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:54:44] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:54:47] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:54:51] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:54:54] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:54:57] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:55:00] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
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tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:55:03] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:55:07] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:55:10] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
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tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
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[20:55:13] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:55:16] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:55:19] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:55:22] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
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Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:55:25] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
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tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:55:28] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:55:31] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:55:34] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:55:37] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:55:40] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
The performance of xgboosting is 0.8545313991409481 spending 196.177726 seco
nds. The xgboosting has higher score compare to 3.1 but spending more time.
```

3.3: Compare the results on the test dataset from XGBoost, HistGradientBoostingClassifier, GradientBoostingClassifier with results from Q1.6 and Q2.1. Which model tends to perform the best and which one does the worst? How big is the difference between the two? Which model would you choose among these 5 models and why?

In [26]:
```
## YOUR ANSWER HERE
print(f"The XGBoost performs the best with a score of {xgb_best_score}, \
and Decision Tree in 1.6 with pure leaves perform the worst with a score of
I would choose HistGradientBoostingClassifier because it performs almost as
```

```
The XGBoost performs the best with a score of 0.8567585706331531, and Decisi
on Tree in 1.6 with pure leaves perform the worst with a score of 0.47517730
4964539. I would choose HistGradientBoostingClassifier because it performs a
lmost as good as XGBoost and uses much less time.
```

3.4: Can you list the top 3 features from the trained XGBoost model? How do they differ from the features found from Random Forest and Decision Tree? Which one would you trust the most?

In [21]:
```
## YOUR CODE HERE
warnings.simplefilter(action='ignore', category=UserWarning)
best_xgb = XGBClassifier(n_estimators=ns[np.argmax(xgb_scores)], max_depth =
best_xgb.fit(bank_X_train,bank_y_train)
feature_impors = list(zip(bank_X_train.columns,best_xgb.feature_importances_
```

```
feats, imps = zip(*(sorted(list(filter(lambda x:x[1]!=0,feature_impors)),key
ax = sns.barplot(list(imps),list(feats))
ax.tick_params(axis='x',rotation=90)
plt.show()
print("The top 3 features are isActiveMember, Age, and NumofProducts. It is
from the Random Forest as the isActiveMember is replaced by Balance. I would
The XGBoost has the highest score of performance. In the XGBoost features, B
and its value is way below the top 3.")
```

```
[20:55:43] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
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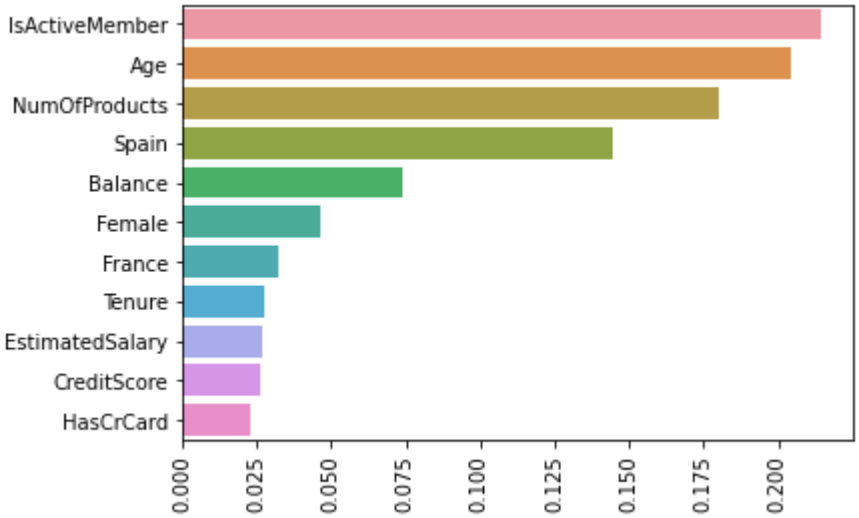
eval_metric if you'd like to restore the old behavior.
```




```
The top 3 features are isActiveMember, Age, and NumofProducts. It is same as
the Decision tree but different from the Random Forest as the isActiveMember
is replaced by Balance. I would choose isActiveMember, Age, and NumofProduct
s. The XGBoost has the highest score of performance. In the XGBoost feature
s, Balance is the No.5 important feature, and its value is way below the top
3.
```

3.5: Can you choose the top 7 features (as given by feature importances from XGBoost) and repeat Q3.2? Does this model perform better than the one trained in Q3.2? Why or why not is the performance better?

In [22]:

```
## YOUR CODE HERE
warnings.simplefilter(action='ignore', category=FutureWarning)
warnings.simplefilter(action='ignore', category=UserWarning)
ns = [100,200,300,400,500,600,700,800,900,1000]
depths = [3,4,6,7,8,9,10,11,12,13]
learning_rates = [0.1,0.11,0.12,0.13,0.14,0.15,0.16,0.17,0.18,0.19]
xgb_scores = []
for i in range(10):
    xgb = XGBClassifier(n_estimators=ns[i], max_depth = depths[i],learning_r
    xgb.fit(bank_X_train[list(feats[:7])],bank_y_train)
    xgb_score = cross_val_score(xgb,bank_X_train[list(feats[:7])],bank_y_tra
    xgb_scores.append(np.mean(xgb_score))

xgb_best_score = np.max(xgb_scores)
print(f"The performance of xgboosting is {xgb_best_score} which is almost th
The model performs as good as in Q3.2. This is because the model is most inf
of less important features do not have large impact of the model and its per
almost the same.")
```

```
[20:55:43] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
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[20:55:48] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
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[20:55:50] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
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[20:55:51] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
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[20:55:52] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
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[20:55:59] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
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tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
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[20:56:05] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:56:06] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:56:07] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:56:09] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:56:10] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
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btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:56:11] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:56:12] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:56:13] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:56:14] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:56:16] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:56:17] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:56:19] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:56:20] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:56:22] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:56:23] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:56:25] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:56:27] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
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[20:56:28] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:56:29] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:56:31] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:56:33] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:56:35] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:56:36] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:56:38] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:56:40] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:56:42] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:56:44] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:56:46] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:56:48] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:56:49] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
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eval_metric if you'd like to restore the old behavior.
[20:56:51] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:56:54] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:56:56] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:56:58] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:57:01] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:57:03] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:57:05] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:57:07] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:57:09] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:57:11] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:57:14] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:57:16] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:57:19] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
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tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:57:21] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:57:24] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:57:26] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:57:29] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:57:32] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:57:34] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:57:37] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:57:39] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:57:42] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:57:44] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:57:48] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:57:51] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:57:53] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
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tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:57:56] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:57:59] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:58:03] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:58:05] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:58:08] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:58:11] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
[20:58:14] WARNING: /var/folders/sy/f16zz6x50xz3113nwtb9bvq00000gp/T/abs_44t
btwf8c1/croots/recipe/xgboost-split_1659548960882/work/src/learner.cc:1115:
Starting in XGBoost 1.3.0, the default evaluation metric used with the objec
tive 'binary:logistic' was changed from 'error' to 'logloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
The performance of xgboosting is 0.8567585706331531 which is almost the same
as 0.8567585706331531 in Q3.2. The model performs as good as in Q3.2. This i
s because the model is most influence by the top features. The variance of l
ess important features do not have large impact of the model and its perform
ance. Thus, the performance is almost the same.
```

Question 4: Calibration

4.1: Estimate the brier score for the XGBoost model (trained with optimal hyperparameters from Q3.2) scored on the test dataset.

In [23]:
```
## YOUR CODE HERE
from sklearn.metrics import brier_score_loss
brier_score_loss(bank_y_test,best_xgb.predict(bank_X_test))
```

Out[23]:
```
0.13545454545454547
```

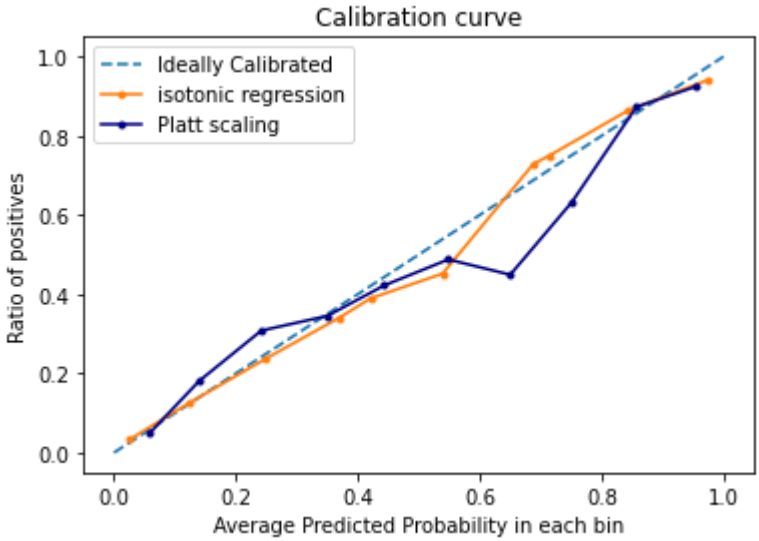
4.2: Calibrate the trained XGBoost model using isotonic regression as well as Platt scaling. Plot predicted v.s. actual on test datasets from both the calibration methods

In [24]:
```
## YOUR CODE HERE
```

```
from sklearn.calibration import CalibratedClassifierCV
from sklearn.calibration import calibration_curve
from sklearn.calibration import CalibrationDisplay
cal_ir = CalibratedClassifierCV(best_xgb,cv="prefit",method="isotonic")
cal_ir.fit(bank_X_train, bank_y_train)
cal_ir_predict = cal_ir.predict_proba(bank_X_test)
cal_ir_true, cal_ir_prob = calibration_curve(bank_y_test, cal_ir_predict[:,1

cal_pl = CalibratedClassifierCV(best_xgb,cv="prefit",method="sigmoid")
cal_pl.fit(bank_X_train, bank_y_train)
cal_pl_predict = cal_pl.predict_proba(bank_X_test)
cal_pl_true, cal_pl_prob = calibration_curve(bank_y_test, cal_pl_predict[:,1

# CalibrationDisplay.from_estimator(cal_ir,bank_X_test,bank_y_test,n_bins=10
# CalibrationDisplay.from_estimator(cal_pl,bank_X_test,bank_y_test,n_bins=10
plt.plot([0, 1], [0, 1], linestyle = '--', label = 'Ideally Calibrated')
plt.plot(cal_ir_prob,cal_ir_true,marker = '.', label = 'isotonic regression'
plt.plot(cal_pl_prob,cal_pl_true,marker = '.', c= 'navy', label = 'Platt sca
plt.legend(loc = 'upper left')
plt.xlabel('Average Predicted Probability in each bin')
plt.ylabel('Ratio of positives')
plt.title("Calibration curve")
plt.show()
```



4.3: Report brier scores from both the calibration methods. Do the calibration methods help in having better predicted probabilities?

In [25]:
```
## YOUR CODE HERE
print(f"The brier score for isotnic regression is: {brier_score_loss(bank_y_
print(f"The brier score for Platt scaling regression is: {brier_score_loss(b
print("THe calibration methods are not helping in having better predicted pr
```

```
The brier score for isotnic regression is: 0.13696969696969696
The brier score for Platt scaling regression is: 0.13575757575757577
THe calibration methods are not helping in having better predicted probabili
ties.
```