In [ ]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.experimental import enable_halving_search_cv
from sklearn.neural_network import MLPClassifier
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import accuracy_score, confusion_matrix, roc_curve, roc_auc_score, precision_recall_curve, precision_score, recall_score, f1_score, classifica
from sklearn.model_selection import train_test_split, GridSearchCV, HalvingGridSearchCV, cross_val_score, cross_validate
from sklearn.preprocessing import StandardScaler
from sklearn.utils import resample
import xgboost as xgb

import tensorflow as tf

pd.options.display.max_columns = None
```

In [ ]:
```
df_covid = pd.read_csv('./Covid_clean_total.csv')
df_covid.head()
```

```
C:\Users\ismael\AppData\Local\Temp\ipykernel_33232\1680001913.py:1: DtypeWarning: Columns (4,23) have mixed types. Specify dtype option on import or set low_memory=
False.
  df_covid = pd.read_csv('./Covid_clean_total.csv')
```

Out[ ]:

	USMER	MEDICAL_UNIT	SEX	PATIENT_TYPE	DATE_DIED	INTUBED	PNEUMONIA	AGE	PREGNANT	DIABETES	COPD	ASTHMA	INMSUPR	HIPERTENSION	OTHER_DISEASE
0	2	1	1	1	2020-05-03	NaN	1.0	65.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0
1	2	1	0	1	2020-06-03	NaN	1.0	72.0	NaN	0.0	0.0	0.0	0.0	1.0	0.0
2	2	1	0	0	2020-06-09	1.0	0.0	55.0	NaN	1.0	0.0	0.0	0.0	0.0	0.0
3	2	1	1	1	2020-06-12	NaN	0.0	53.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	2	1	0	1	2020-06-21	NaN	0.0	68.0	NaN	1.0	0.0	0.0	0.0	1.0	0.0

In [ ]:
```
# creamos el modelo de clasificacion

features = ['USMER', 'SEX','INTUBED', 'PNEUMONIA','AGE', 'PREGNANT', 'DIABETES', 'COPD', 'ASTHMA', 'INMSUPR', 'HIPERTENSION', 'OTHER_DISEASE', 'CARDIOVASCULAR', 'O
target = 'fallecidos'
```

In [ ]:
```
df_covid.shape
```

Out[ ]:
```
(1048575, 24)
```

Rebalanceo y xGboost

In [ ]:
```
clase_mayoritaria = df_covid[df_covid['fallecidos'] == 0]
clase_minoritaria = df_covid[df_covid['fallecidos'] == 1]

clase_mayoritarial_downsampled = resample(clase_mayoritaria,
                                          replace = False,
                                          n_samples = len(clase_minoritaria),
                                          random_state = 42)

df_covid_downsampled = pd.concat([clase_mayoritarial_downsampled, clase_minoritaria])

df_covid_downsampled['fallecidos'].value_counts()
```

Out[ ]:
```
fallecidos
0    76942
1    76942
Name: count, dtype: int64
```

In [ ]:
```
X = df_covid_downsampled[features]
y = df_covid_downsampled[target]

# X = df_covid[features]
# y = df_covid[target]
```

Cremos modelo y lo entrenamos. Usamos Xgboost y best params para obtener los mejores hiperparametros.

In [ ]:
```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)

model = xgb.XGBClassifier()
model.fit(X_train, y_train)

# Definición de los hiperparámetros a ajustar
param_grid = {
    'learning_rate': [0.1, 0.01, 0.001],
    'max_depth': [3, 5, 7],
    'n_estimators': [100, 200, 300],
}

# Instancia de Grid Search Cross Validation
grid_search = GridSearchCV(model, param_grid, scoring='accuracy', cv=5)

# Entrenamiento del modelo con Grid Search
grid_search.fit(X_train, y_train)

# Mejores hiperparámetros encontrados
best_params = grid_search.best_params_
print("Mejores hiperparámetros:", best_params)
```

```
Mejores hiperparámetros: {'learning_rate': 0.1, 'max_depth': 3, 'n_estimators': 300}
```

Evaluamos el modelo con los datos de test

In [ ]:
```
# Evaluación del modelo con los mejores hiperparámetros en el conjunto de prueba
best_model = grid_search.best_estimator_
y_pred = best_model.predict(X_test)
```

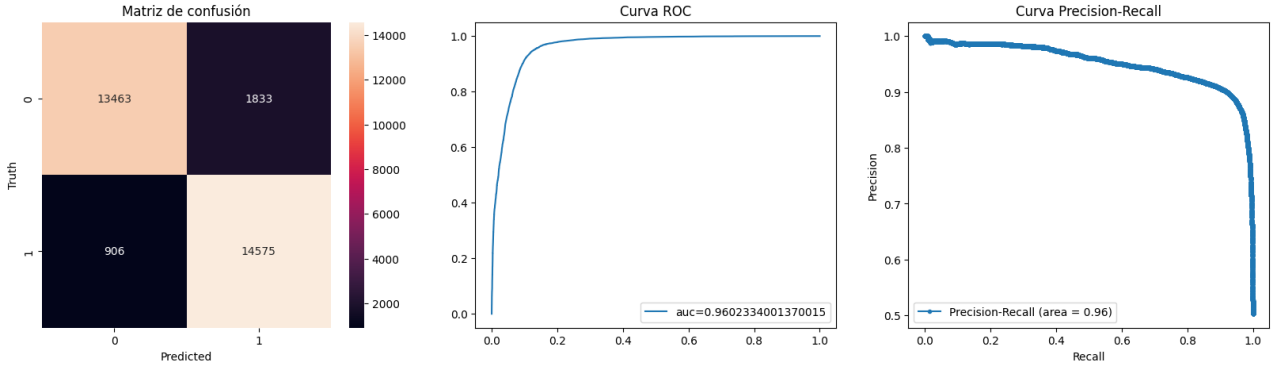
```
accuracy = accuracy_score(y_test, y_pred)
print("Accuracy:", accuracy)
```

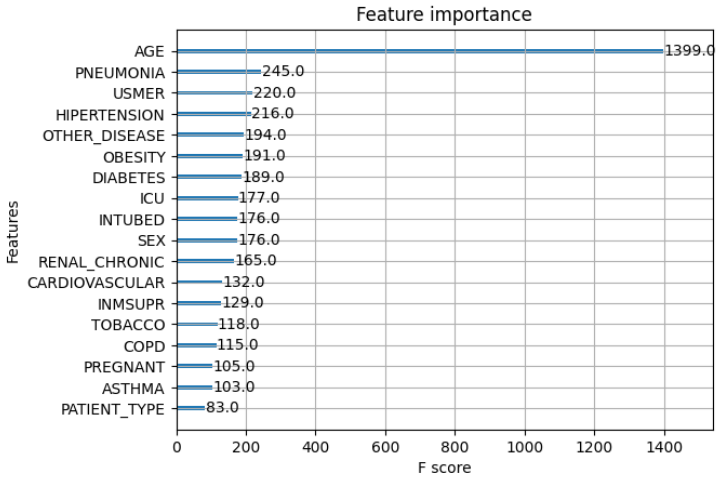
```
Accuracy: 0.9110049712447607
```

In [ ]:

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

accuracy = accuracy_score(y_test, y_pred)
print("Accuracy:", accuracy)

precision = precision_score(y_test, y_pred)
print("Precision:", precision)

recall = recall_score(y_test, y_pred)
print("Recall:", recall)

f1 = f1_score(y_test, y_pred)
print("F1:", f1)


# grafiocamos la matriz de confusión

cm = confusion_matrix(y_test, y_pred)

print(f'Matriz de confusión: {cm}')
# Curva ROC

y_pred_proba = model.predict_proba(X_test)[:,1]
fpr, tpr, _ = roc_curve(y_test,  y_pred_proba)
auc = roc_auc_score(y_test, y_pred_proba)

# Curva Precision-Recall

precision, recall, _ = precision_recall_curve(y_test, y_pred_proba)

# ploteo los 3 graficos en un mosaico

fig, ax = plt.subplots(1, 3, figsize=(20, 5))

sns.heatmap(cm, annot=True, fmt='d', ax=ax[0])
ax[0].set_xlabel('Predicted')
ax[0].set_ylabel('Truth')
ax[0].set_title('Matriz de confusión')

ax[1].plot(fpr,tpr,label="auc="+str(auc))
ax[1].legend(loc=4)
ax[1].set_title('Curva ROC')

ax[2].plot(recall, precision, marker='.', label='Precision-Recall (area = %0.2f)' % auc)
ax[2].legend(loc="lower left")
ax[2].set_xlabel('Recall')
ax[2].set_ylabel('Precision')
ax[2].set_title('Curva Precision-Recall')

xgb.plot_importance(model)

plt.show()
```

```
              precision    recall  f1-score   support

           0       0.94      0.88      0.91     15296
           1       0.89      0.94      0.91     15481

    accuracy                           0.91     30777
   macro avg       0.91      0.91      0.91     30777
weighted avg       0.91      0.91      0.91     30777

Accuracy: 0.9110049712447607
Precision: 0.8882862018527548
Recall: 0.9414766487952975
F1: 0.9141083132114523
Matriz de confusión: [[13463  1833]
 [  906 14575]]
```





Analisis de falsos negativos

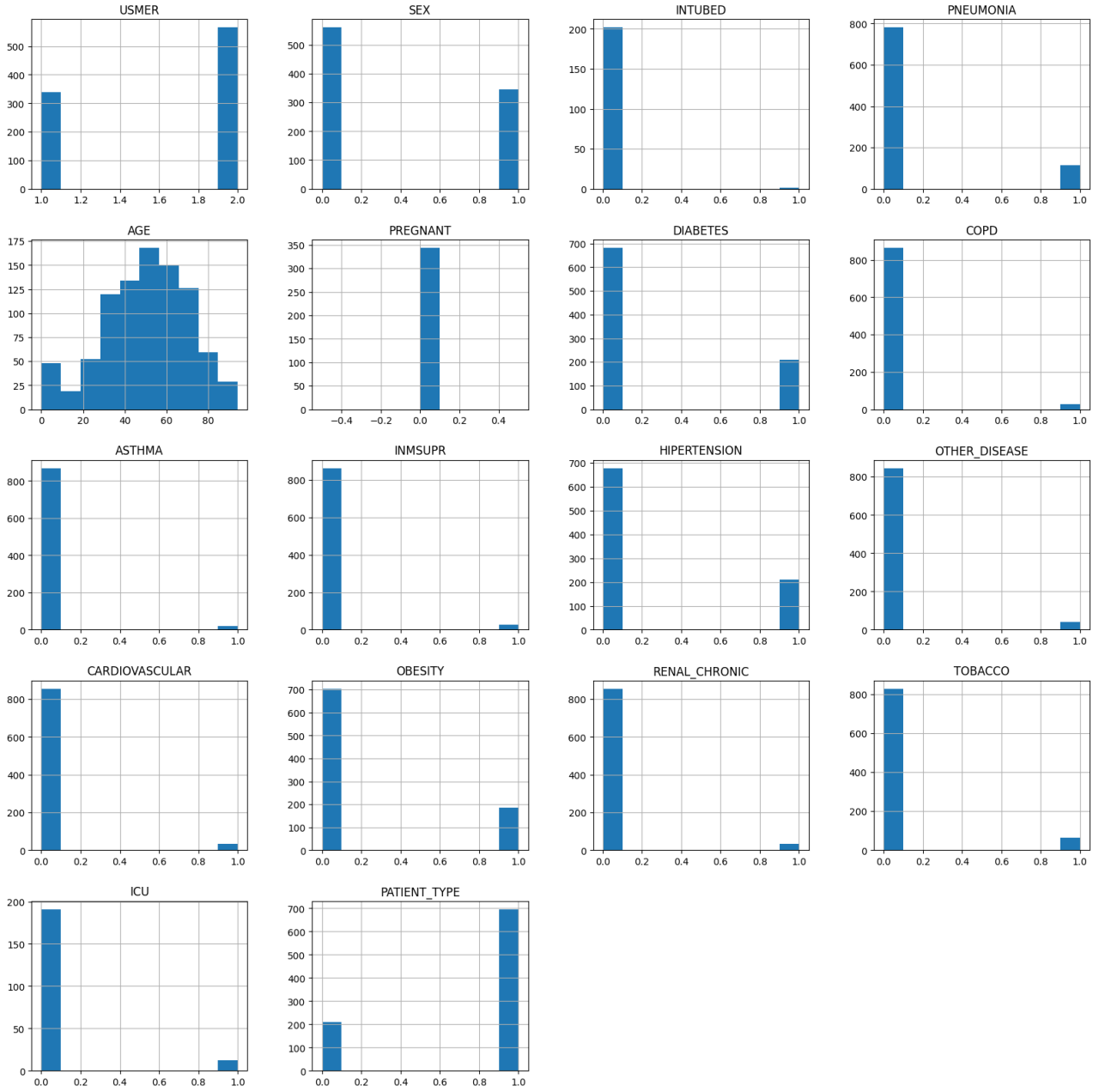
In [ ]:
```
# buscamos los falsos negativos y armamos un df con ellos

falsos_negativos = np.where((y_test == 1) & (y_pred == 0))[0]

# Busco los indices de los falsos negativos
indices = X_test.iloc[falsos_negativos].index

# Armo un df con los falsos negativos

df_falsos_negativos = df_covid_downsampled.loc[indices]

df_falsos_negativos['falsos_negativos'] = y_pred[falsos_negativos]

features = ['USMER', 'SEX','INTUBED', 'PNEUMONIA', 'AGE','PREGNANT', 'DIABETES', 'COPD', 'ASTHMA', 'INMSUPR', 'HIPERTENSION', 'OTHER_DISEASE', 'CARDIOVASCULAR', 'O
df_falsos_negativos[features].head(10)
```

Out[ ]:

	USMER	SEX	INTUBED	PNEUMONIA	AGE	PREGNANT	DIABETES	COPD	ASTHMA	INMSUPR	HIPERTENSION	OTHER_DISEASE	CARDIOVASCULAR	OBESITY	RENAL_C
24225	2	0	0.0	0.0	41.0	NaN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
22108	2	0	NaN	0.0	65.0	NaN	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
43830	2	0	0.0	0.0	32.0	NaN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
56641	1	0	NaN	1.0	31.0	NaN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
444764	1	0	NaN	NaN	0.0	NaN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
23166	2	0	NaN	0.0	67.0	NaN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
29127	1	0	NaN	0.0	45.0	NaN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
36313	2	0	NaN	0.0	56.0	NaN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
457083	2	1	0.0	0.0	25.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
431868	2	1	NaN	0.0	72.0	0.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	

In [ ]:
```
# graficamos las variables de df_falsos_negativos

df_falsos_negativos[features].hist(figsize=(20,20))
# agrego titulo

plt.suptitle('Histogramas de variables de los falsos negativos', fontsize=20)
plt.savefig('histogramas_falsos_negativos.png')
plt.show()
```

Histogramas de variables de los falsos negativos



In [ ]:
```
# buscamos los falsos positivos y armamos un df con ellos

falsos_positivos = np.where((y_test == 0) & (y_pred == 1))[0]

# Busco los indices de los falsos negativos
indices = X_test.iloc[falsos_positivos].index

# Armo un df con los falsos negativos

df_falsos_positivos = df_covid_downsampled.loc[indices]

df_falsos_positivos['falsos_negativos'] = y_pred[falsos_positivos]

features = ['USMER', 'SEX','INTUBED', 'PNEUMONIA', 'AGE','PREGNANT', 'DIABETES', 'COPD', 'ASTHMA', 'INMSUPR', 'HIPERTENSION', 'OTHER_DISEASE', 'CARDIOVASCULAR', 'O
df_falsos_positivos[features].head(10)
```

Out[ ]:

	USMER	SEX	INTUBED	PNEUMONIA	AGE	PREGNANT	DIABETES	COPD	ASTHMA	INMSUPR	HIPERTENSION	OTHER_DISEASE	CARDIOVASCULAR	OBESITY	RENAL_C
136857	1	0	0.0	1.0	38.0	NaN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
67591	1	1	0.0	1.0	60.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	1.0	
283731	1	0	0.0	0.0	46.0	NaN	1.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
223771	1	1	NaN	NaN	83.0	0.0	1.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
351201	2	0	0.0	1.0	70.0	NaN	1.0	0.0	0.0	0.0	1.0	0.0	0.0	1.0	
580727	1	1	0.0	0.0	48.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
293888	1	1	0.0	1.0	60.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	1.0	1.0	
300197	1	1	0.0	0.0	65.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
577942	2	1	NaN	1.0	63.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
153346	2	0	0.0	1.0	79.0	NaN	0.0	0.0	0.0	0.0	1.0	0.0	0.0	1.0	

In [ ]:

```
df_falsos_positivos[features].hist(figsize=(20,20))
# agrego titulo

plt.suptitle('Histogramas de variables de los falsos positivos', fontsize=20)
plt.savefig('histogramas_falsos_positivos.png')
plt.show()
```

Histogramas de variables de los falsos positivos