Algorithmes de Machine Learning

Dans ce Notebook, nous évaluerons plusieurs approches d'apprentissage automatique pour prédire la probabilité de réadmission à l'hôpital pour les patients diabétiques.

In [1]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import time
from sklearn.linear_model import LogisticRegression
from sklearn.ensemble import RandomForestClassifier
from sklearn.tree import DecisionTreeClassifier
from sklearn.svm import SVC
from sklearn.pipeline import Pipeline
from sklearn.preprocessing import StandardScaler, PowerTransformer, LabelEncoder, OneHotEncoder
from sklearn.metrics import classification_report, confusion_matrix, precision_score, recall_score, f1_score
from sklearn.metrics import recall_score, f1_score, confusion_matrix, classification_report, accuracy_score,
```

In [2]:
```
df=pd.read_csv('CSV_Files/Diabetes_cleaned.csv')
df.head()
```

Out[2]:

	RACE	GENDER	AGE_INT	DISCHARGE_DISPOSITION	ADMISSION_SOURCE	TIME_IN_HOSPITAL	MEDICAL_SPECIALTY	NUM_LAB_PROCE
0	Caucasian	0	65	Discharged to home	Referral	3	Nephrology	
1	Caucasian	0	75	Transferred to another medical facility	Emergency	3	Orthopedics-Reconstructive	
2	Caucasian	0	95	Discharged to home	Emergency	4	Emergency/Trauma	
3	Caucasian	1	75	Transferred to another medical facility	Emergency	10	InternalMedicine	
4	Caucasian	1	55	Left AMA	Transferred from another health care facility	6	Nephrology	

5 rows × 29 columns

In [3]:
```
df.columns
```

Out[3]:
```
Index(['RACE', 'GENDER', 'AGE_INT', 'DISCHARGE_DISPOSITION',
       'ADMISSION_SOURCE', 'TIME_IN_HOSPITAL', 'MEDICAL_SPECIALTY',
       'NUM_LAB_PROCEDURES', 'NUM_PROCEDURES', 'NUM_MEDICATIONS',
       'DIAG_1', 'DIAG_2', 'DIAG_3', 'NUMBER_DIAGNOSES', 'MAX_GLU_SERUM', 'A1CRESULT',
       'METFORMIN', 'REPAGLINIDE', 'GLIMEPIRIDE', 'GLIPIZIDE', 'GLYBURIDE',
       'PIOGLITAZONE', 'ROSIGLITAZONE', 'INSULIN', 'DIABETESMED', 'READMITTED',
       'preceding_year_visits', 'number_changes', 'insulin_treatment'],
      dtype='object')
```

In [4]:
```
X = df.drop('READMITTED', 1)
X_dum = pd.get_dummies(X, drop_first = True)
y = df['READMITTED']

from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X_dum, y, random_state = 0, test_size = 0.3, stratify =

X_train.shape, X_test.shape, y_train.shape, y_test.shape
```

Out[4]:
```
((17735, 145), (7602, 145), (17735,), (7602,))
```

In [5]:
```
X_train.columns = ["".join (c if c.isalnum() else "_" for c in str(x)) for x in X_train.columns]
X_test.columns = ["".join (c if c.isalnum() else "_" for c in str(x)) for x in X_test.columns]
```

Arbres de décisions

In [6]:
```
from sklearn.tree import DecisionTreeClassifier
DT = DecisionTreeClassifier(random_state = 0)

DT.fit(X_train,y_train)
imp = pd.DataFrame(DT.feature_importances_,index=X_train.columns,columns=['Importance'])
imp.sort_values(by='Importance',ascending=False)
```

Out[6]:

	Importance
NUM_LAB_PROCEDURES	0.102829
NUM_MEDICATIONS	0.080634
TIME_IN_HOSPITAL	0.058017
preceding_year_visits	0.049388
AGE_INT	0.041802
...	...
DIAG_2_Sense_Organs	0.000000
MEDICAL_SPECIALTY_Gynecology	0.000000
MEDICAL_SPECIALTY_Endocrinology_Metabolism	0.000000
MEDICAL_SPECIALTY_Endocrinology	0.000000
MEDICAL_SPECIALTY_Neurophysiology	0.000000

145 rows × 1 columns

In [7]:
```
tree = DecisionTreeClassifier(random_state = 0, class_weight = 'balanced',max_depth=2)
tree.fit(X_train, y_train)

import os
os.environ['PATH'] = os.environ['PATH']+';'+os.environ['CONDA_PREFIX']+r'\Library\bin\graphviz'

from IPython.display import Image
#from sklearn.externals.six import StringIO
from sklearn.tree import export_graphviz
import pydotplus

features = X_train.columns
# Create DOT data
dot_data = export_graphviz(tree, out_file=None, feature_names=features)

# Draw graph
graph = pydotplus.graph_from_dot_data(dot_data)

# Show graph
Image(graph.create_png())
```

Out[7]:

Random Forest

In [8]:
```
from sklearn.ensemble import RandomForestClassifier
rf = RandomForestClassifier(random_state = 0, n_jobs = -1,class_weight='balanced_subsample')
Rf_fit(X_train,y_train)
imp = pd.DataFrame(Rf_feature_importances_,index=X_train.columns,columns=['Importance'])
imp.sort_values(by='Importance',ascending=False)
```

Out[8]:

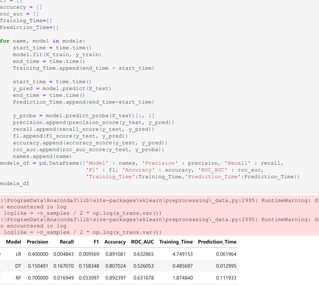
	Importance
NUM_LAB_PROCEDURES	8.188810e-02
NUM_MEDICATIONS	7.684449e-02
preceding_year_visits	5.497408e-02
TIME_IN_HOSPITAL	5.600393e-02
AGE_INT	4.729242e-02
...	...
DISCHARGE_DISPOSITION_Not_Available	4.577222e-21
MEDICAL_SPECIALTY_Pediatrics_Pulmonology	0.000000e+00
MEDICAL_SPECIALTY_Neurophysiology	0.000000e+00
MEDICAL_SPECIALTY_SportsMedicine	0.000000e+00
MEDICAL_SPECIALTY_Perinatology	0.000000e+00

145 rows × 1 columns

In [9]:
```
from sklearn.ensemble import RandomForestClassifier

rf = RandomForestClassifier(random_state = 0, n_jobs = -1)
rf.fit(X_train, y_train)
y_train_pred = rf.predict(X_train)
y_train_prob = rf.predict_proba(X_train)[:, 1]
y_test_pred = rf.predict(X_test)
y_test_prob = rf.predict_proba(X_test)[:, 1]

print("Train Accuracy Score:", accuracy_score(y_train, y_train_pred))
print("Train Confusion Matrix:\n", confusion_matrix(y_train, y_train_pred), '\n')
print("Train F1 Score:", f1_score(y_train, y_train_pred))
print("Train Precision Score:", precision_score(y_train, y_train_pred))
print("Train Recall Score:", recall_score(y_train, y_train_pred))
print("Train ROC_AUC Score:", roc_auc_score(y_train, y_train_prob))
print()
print("Test Accuracy Score:", accuracy_score(y_test, y_test_pred))
print("Test Confusion Matrix:\n", confusion_matrix(y_test, y_test_pred), '\n')
print("Test F1 Score:", f1_score(y_test, y_test_pred))
print("Test Precision Score:", precision_score(y_test, y_test_pred))
print("Test Recall Score:", recall_score(y_test, y_test_pred))
print("Test ROC_AUC Score:", roc_auc_score(y_test, y_test_prob))
```

```
Train Accuracy Score: 1.0
Train Confusion Matrix:
 [[15907     0]
 [    0 19281]]

Train F1 Score: 1.0
Train Precision Score: 1.0
Train Recall Score: 1.0
Train ROC_AUC Score: 0.9999999999999999

Test Accuracy Score: 0.8923963737006051
Test Confusion Matrix:
 [[6770   66]
 [ 812  154]]

Test F1 Score: 0.2333096926713947
Test Precision Score: 0.7
Test Recall Score: 0.21659493524237288
Test ROC_AUC Score: 0.6361778024418901
```

In [10]:
```
from sklearn.metrics import precision_recall_curve

plt.figure(figsize = (8, 5))
prec, rec, thresh = precision_recall_curve(y_test, y_test_prob)
plt.plot(thresh, prec[1:], marker = 'o', c = 'b', label = 'Precision')
plt.plot(thresh, rec[1:], marker = 'x', c = 'g', label = 'Recall')
plt.legend(loc = 'center left')
plt.xlabel("Thresholds")
plt.ylabel('Precision and Recall')
plt.title('Precision Recall Tradeoff')
plt.show()
```



In [11]:
```
from sklearn.metrics import roc_curve
plt.figure(figsize = (8, 5))
# calculate roc curves
fpr, tpr, thresholds = roc_curve(y_test, y_test_prob)
# calculate the g-mean for each threshold
gmeans = np.sqrt(tpr * (1-fpr))
# locate the index of the largest g-mean
ix = np.argmax(gmeans)
print('Best Threshold=%f, G-Mean=%.3f' % (thresholds[ix], gmeans[ix]))
# plot the roc curve for the model
plt.plot([0,1], [0,1], linestyle='--', label='No Skill')
plt.plot(fpr, tpr, marker='.', label='LGBMClassifier')
plt.scatter(fpr[ix], tpr[ix], marker='o', color='black', alpha = 1, edgecolors = 'k', s = 100,
            label='Best Threshold: '+str(round(thresholds[ix], 3)))

# axis labels
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('ROC Curve')
plt.legend(loc = 'best')
# show the plot
plt.show()
```

```
Best Threshold=0.120000, G-Mean=0.594
```

Regression logistique + SVM

In [12]:
```
models = []

models.append(('LR', Pipeline([('Transformer', PowerTransformer()),
                               ('Scaler', StandardScaler()),
                               ('LogReg', LogisticRegression(random_state = 0, solver = 'liblinear'))])))

models.append(('DT', DecisionTreeClassifier(random_state = 0)))
models.append(('RF', RandomForestClassifier(random_state = 0, n_jobs = -1)))
models.append(('SVC', Pipeline([('Transformer', PowerTransformer()),
                                ('Scaler', StandardScaler()),
                                ('SVC', SVC(random_state = 0, probability=True))])))



## Validation Set Scores
precision = []
recall = []
names = []
f1 = []
accuracy = []
roc_auc = []
Training_Time=[]
Prediction_Time=[]

for name, model in models:
    start_time = time.time()
    model.fit(X_train, y_train)
    end_time = time.time()
    Training_Time.append(end_time - start_time)

    start_time = time.time()
    y_pred = model.predict(X_test)
    end_time = time.time()
    Prediction_Time.append(end_time-start_time)

    y_probs = model.predict_proba(X_test)[:, 1]
    precision.append(precision_score(y_test, y_pred))
    recall.append(recall_score(y_test, y_pred))
    f1.append(f1_score(y_test, y_pred))
    accuracy.append(accuracy_score(y_test, y_pred))
    roc_auc.append(roc_auc_score(y_test, y_probs))
    names.append(name)

models_df = pd.DataFrame({'Model' : names, 'Precision' : precision, 'Recall' : recall,
                          'F1' : f1, 'Accuracy' : accuracy, 'ROC_AUC' : roc_auc,
                          'Training_Time':Training_Time,'Prediction_Time':Prediction_Time})

models_df
```

```
C:\ProgramData\Anaconda3\lib\site-packages\sklearn\preprocessing\_data.py:2995: RuntimeWarning: divide by ze
ro encountered in log
  loglike = -n_samples / 2 * np.log(x_trans.var())
C:\ProgramData\Anaconda3\lib\site-packages\sklearn\preprocessing\_data.py:2995: RuntimeWarning: divide by ze
ro encountered in log
  loglike = -n_samples / 2 * np.log(x_trans.var())
```

Out[12]:

	Model	Precision	Recall	F1	Accuracy	ROC_AUC	Training_Time	Prediction_Time
0	LR	0.400000	0.004641	0.009169	0.891084	0.632865	4.749153	0.061964
1	DT	0.150491	0.167070	0.158348	0.807024	0.526053	0.485697	0.012995
2	RF	0.700000	0.016949	0.033097	0.892397	0.631678	1.874840	0.111933
3	SVC	0.600000	0.007264	0.014354	0.891607	0.567139	390.847938	9.523127

Les résultats peuvent être amélioré