EXPERIMENT REPORT

Student Name	Sudarat Sukjaroen
Project Name	Experiment on Logistic Regression model
Date	24 August 2023
Deliverables	sukjaroen_sudarat-24667255-week2_smote.ipynb
Github repository	https://github.com/sudarat-pom/AdvanceML_AT1

1. EXPERIMENT BACKGROUND	
Provide information about the problem/project such as the scope, the overall objective, expectations. Lay down the goal of this experiment and what are the insights, answers you want to gain or level of performance you are expecting to reach.	
1.a. Business Objective	The NBA draft is an annual event in which teams select players from their American colleges as well as international professional leagues to join their rosters. Moving to the NBA league is a big deal for any basketball player. Sport commentators and fans are very excited to follow the careers of college players and guess who will be drafted by an NBA team. Data science is tasked to build a model that will predict if a college basketball player will be drafted to join the NBA league based on his statistics for the current season.
1.b. Hypothesis	Null Hypothesis (H0): There is no significant relationship between a college basketball player's statistics for the current season and their likelihood of being drafted to the NBA league. Alternative Hypothesis (H1): There is a significant relationship between a college basketball player's statistics for the current season and their likelihood of being drafted to the NBA league. Evaluate the model regarding the accuracy, precision, recall, and F1 score on the player statistics data and split the train and test data set (80:20). Predict with test data set to calculate probability value for each player_id and submit predictions file in Kaggle to check the score.
1.c. Experiment Objective	The project expects to apply machine learning techniques to calculate the best probability value for each player_id and submit a prediction file in Kaggle. The project expectation is to improve the score every week.

2. EXPERIMENT DETAILS

Elaborate on the approach taken for this experiment. List the different steps/techniques used and explain the rationale for choosing them.

2.a. Data Preparation

Data exploration

1. Read train and test data from a CSV file.
2. Display data information.
3. Display data description.
4. Display the data top 10 rows.
5. Count distinct value of drafted column in Train data set and found
Number of distinct values in drafted: 2
0.0 = 55,555
1.0 = 536

Data cleansing and data preparation

1. Check the number of records and columns.
Train data set: number of record = 56,091, Number of column = 64
Test data set: number of record = 4,970, Number of column = 63

2. Identify, remove duplicate records, and not find duplicates in a data frame.
3. Check the Null value and found as following column names, replace them with 0 and not find the Null target value.

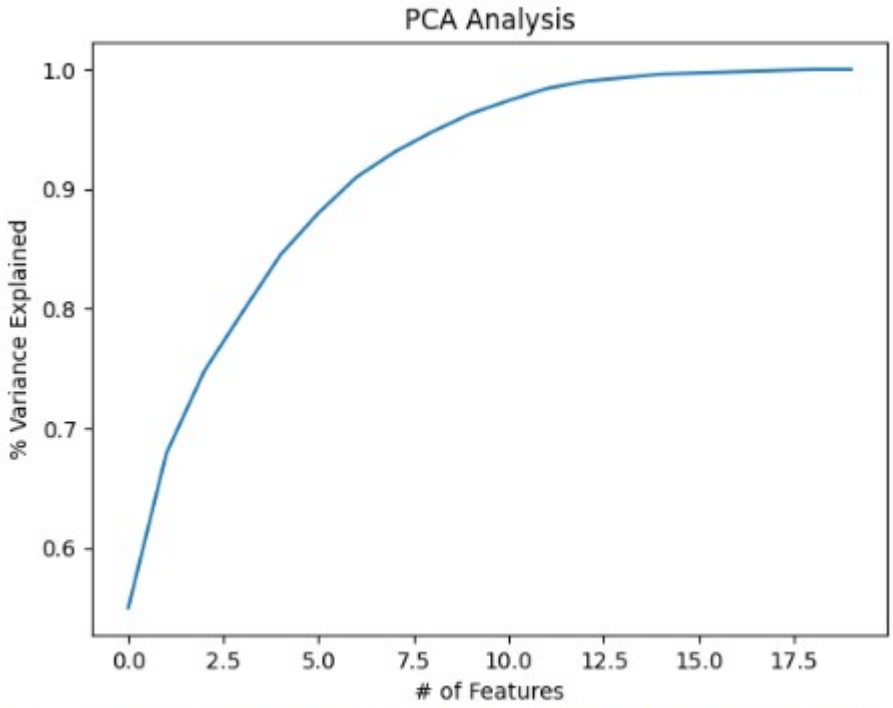
Train data

```
Columns with null values in Train data set:
yr                      274
ht                       80
num                    4669
Rec_Rank              39055
ast_tov                4190
rimmade                6081
rimmade_rimmiss        6081
midmade                6081
midmade_midmiss        6081
rim_ratio              9464
mid_ratio              9688
dunksmade              6081
dunksmiss_dunksmade    6081
dunks_ratio           30793
pick                  54705
drtg                     44
adrtg                    44
dporpag                  44
stops                    44
bpm                      44
obpm                     44
dbpm                     44
gbpm                     44
mp                       38
ogbpm                    44
dgbpm                    44
oreb                     38
dreb                     38
treb                     38
ast                      38
stl                      38
blk                      38
pts                      38
dtype: int64
```

	Test data Columns with null values in Train data set: ht 6 num 88 Rec_Rank 3536 ast_tov 537 rimmade 248 rimmade_rimmiss 248 midmade 248 midmade_midmiss 248 rim_ratio 646 mid_ratio 697 dunksmade 248 dunksmiss_dunksmade 248 dunks_ratio 2717 pick 4921 drtg 1 adrtg 1 dporpag 1 stops 1 bpm 1 obpm 1 dbpm 1 gbpm 1 ogbpm 1 dgbpm 1 dtype: int64
2.b. Feature Engineering	<u>Mapping columns from text to number</u> 1. Team to team_number 2. Conf to conf_number 3. Yr to yr_number 4. Ht to ht_number 5. Num to num_number 6. Player_id to player_number <u>Calculate Information Gain (IG)</u> Calculate Information Gain from 69 features and find the top 20 influences as follows, but for the first trial, I decide to use all features to predict. pick: 0.03795213649565099 dporpag: 0.023214999631525624 porpag: 0.022102364706616195 gbpm: 0.02139306348854475 bpm: 0.019259731075576658 stops: 0.018922022782925096 ogbpm: 0.01845620142715354 adjoe: 0.01842138862800269 Rec_Rank: 0.016650354956799007 twoPM: 0.016645421479337896 pts: 0.016634762050635632 twoPA: 0.01573814733641965 FTM: 0.01536598217175833 obpm: 0.015249632005036817 FTA: 0.014411160875968498 dreb: 0.013238482990499456 mp: 0.012233762570631468 team_number: 0.011951887246710147 rimmade: 0.011627495017502376 midmade_midmiss: 0.011453766614785255

Calculate Principal Component Analysis (PCA)

Calculate PCA 80%, 90%, and 100%, but the number of components for 80% and 90% is almost the same as 100%. Then I decide to use 100% to experiment.




```
[0.55  0.679 0.748 0.797 0.845 0.88  0.91  0.931 0.948 0.963 0.974 0.984
 0.99  0.993 0.996 0.997 0.998 0.999 1.    1.   ]
```

2.c. Modelling

The first experiment is the Logistic Regression model.

1. Find the best set of hyperparameters

Split data percentage : 80:20

Define the set of hyperparameters to find which value is best from this list.

No SMOTE

```
param_grid = {
    'penalty': ['l1', 'l2'],
    'C': [0.01, 0.1, 1, 10],
    'solver': ['liblinear', 'lbfgs', 'newton-cg', 'sag', 'saga'],
    'class_weight': [None, 'balanced'],
    'max_iter': [100, 200, 300],
    'fit_intercept': [True, False],
    'multi_class': ['ovr', 'multinomial'],
    'dual': [True, False],
    'warm_start': [True, False],
    'tol': [1e-4, 1e-3, 1e-2],
}
```

I did not wait until the execution finished. I ran 2 times and stopped at 1 hour 17 minutes 7 seconds and 5 hours 14 minutes 9 seconds.

With SMOTE

```
param_grid = {
    'C': [0.01, 0.1, 1, 10],
    'penalty': ['l1', 'l2'],
```

'class_weight': [None, 'balanced'],
'max_iter': [100, 200, 300],
}
Best Parameters: {'C': 0.1, 'class_weight': None, 'max_iter': 300, 'penalty': 'l2'}
Best Score: 0.9892764712501407
Execution time: 5 minute 52 seconds

With SMOTE
param_grid = {
'penalty': ['l1', 'l2'],
'C': [0.01, 0.1, 1, 10],
}
Best Parameters: {'C': 10, 'penalty': 'l2'}
Best Score: 0.985529425002813
Execution time: 35 seconds

2. The best hyperparameters are these values.

With SMOTE
Best Hyperparameters: {'C': 1, 'penalty': 'l2'}
Best Score: 0.9850343197929561
Execution time: 14 seconds

No SMOTE
Text column
Remove outlier from yr
Accuracy: 0.9939062640021508

Remove outlier from ht
Accuracy: 0.9920955717237043

Number column order by Information Gain
Remove outlier from pick
Accuracy: 0.7841726618705036

Remove outlier from dporpag
Accuracy: 0.9936471009305655

Remove outlier from porpag
Accuracy: 0.9934675615212528

Remove outlier from gbpm
Accuracy: 0.9922126745435016

Remove outlier from bpm
Accuracy: 0.9926628489620616

Remove outlier from stops
Accuracy: 0.9931102362204725

Remove outlier from ogbpm
Accuracy: 0.9933774834437086

Remove outlier from adjoe
Accuracy: 0.9929058153645104

Remove outlier from pts
Accuracy: 0.991675338189386

Remove outlier from Rec_Rank
Accuracy: 0.9821009389671361

Remove outlier from twoPM
Accuracy: 0.9893021395720856

Remove outlier from twoPA
Accuracy: 0.9934920210394936

Remove outlier from obpm
Accuracy: 0.9930456490727532

Remove outlier from FTM
Accuracy: 0.9925113666755817

Remove outlier from FTA
Accuracy: 0.9916683396908251

Remove outlier from dreb
Accuracy: 0.9916206097343555

Remove outlier from mp
Accuracy: 0.9934926011766804

3. EXPERIMENT RESULTS

Analyse in detail the results achieved from this experiment from a technical and business perspective. Not only report performance metrics results but also any interpretation on model features, incorrect results, risks identified.

3.a. Technical Performance

The first week result

No	Model name	Execution time Find best parameters	Execution time Best parameter
1	Logistic Regression	3 minutes	5 seconds

Score after submit prediction = 0.99365 (17 Aug 23 11.30pm)

The second week could not calculate a better accuracy value than the first week. The best one from removing outliers from yr column and accuracy=0.9939062640021508.

3.b. Business Impact

The impact in the NBA industry is to predict the possibility of the basketball player who has a high probability of joining the professional basketball team from their statistics value.

3.c. Encountered Issues	The problem I found was based on running experiments Google Colab environment. **Problem** 1. The execution time to find the best set of hyperparameters is very long. It is hard to test many times and many sets of hyperparameter possibilities within a time limit. **Solution** <u>Short term solution</u> 1. Reduce the set of hyperparameters to only necessary values and cover a wide range of values. 2. Reduce the split data percentage from 80:20 and 70:30 to only 80:20 based on the metric values. <u>Long term solution</u> 1. Buy more resources from the Google Colab environment. 2. I have more knowledge and experience in tuning the performance of models and execution times.

4. FUTURE EXPERIMENT	
Reflect on the experiment and highlight the key information/insights you gained from it that are valuable for the overall project objectives from a technical and business perspective.	
4.a. Key Learning	Find the best solution with the best probability value within 4 weeks, submit 1 version per week and finalise the best one on the last week. In the first trial, I started with standard techniques. 1. Select from Support Vector Machine and Logistic Regression Model. I selected Logistic Regression Model as the first model because the execution time is faster than SVM. 2. Remove duplicate records in Train and Test data set. 3. Replace the Null value with 0 in Train and Test data set. 4. Map columns from text to number. 5. Find the best set of hyperparameters. In the second week, I tried removing outliers from the text and number columns and applied the SMOTE technique, but it still had no significant improvement.
4.b. Suggestions / Recommendations	In the following experiments, I plan to apply more machine-learning techniques. 1. Run other classification models. 2. Replace the Null value with Means, Median, Mode etc. 3. Remove outlier values. 4. Replace missing value with Means, Median, Mode etc. 5. Adjust the density of the ratio of drafted = 0 and 1. 6. Apply Information Gain (IG). 7. Apply Principal Component Analysis (PCA). All techniques will be considered from Accuracy, Precision, Recall and F1 Score values before run prediction.