

Business Problem Understanding:

Poultry meat are these days the easiest sources to get high quality proteins, minerals and vitamins to balance the human diet. Specially developed breeds both broiler and layer are now available with an ability of quick grown and high feed conversion efficiency.

The Indian Poultry Industry is the 2nd largest in the market, especially the broiler industry segment growing at 8-12% every year. Depending on the farm size poultry farming can be main source of family income or can provide subsidiary income and gainful employment to farmers throughout the years.

But to make poultry farming efficient and more profitable the industries want to have automated monitoring system to get idea on the risks involved in the business. The mortality and feeding process increase the risk in poultry industry to very high level.

This project will allow this business with some best models to go ahead to achieve better results.

```
In [287...]: # import important functions
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import warnings
warnings.filterwarnings('ignore')
```

```
In [288...]: # Load data
data = pd.read_csv('Poultry_Data.csv')
data.head()
```

Out[288...]:

	Sale ID	Gender	Age (months)	Vaccine status	Weight(kg)	Death Rate(%)	Sale (in lakhs)	Profit (%)	Risk (%)	Collection
0	SL001086	Male Bird	5	Yes	5.00	12.0	98.00	90	100	
1	SL001087	Female Bird	4	Yes	0.25	15.0	2.75	86	100	
2	SL001091	Male Bird	1	Yes	0.25	15.9	2.75	86	100	
3	SL001095	Male Bird	0	Yes	0.25	15.0	2.75	86	100	
4	SL001002	Female Bird	3	Yes	0.58	15.0	2.75	90	100	

```
In [289...]: # check data size and column names
data.info()

<class 'pandas.core.frame.DataFrame'>
RangeIndex: 615 entries, 0 to 614
Data columns (total 13 columns):
 #   Column           Non-Null Count  Dtype  
---  -- 
 0   Sale ID          615 non-null    object  
 1   Gender           615 non-null    object  
 2   Age (months)     615 non-null    object  
 3   Vaccine status   615 non-null    object  
 4   Weight(kg)       615 non-null    float64 
 5   Death Rate(%)   615 non-null    float64 
 6   Sale (in lakhs) 615 non-null    float64 
 7   Profit (%)       615 non-null    int64   
 8   Risk (%)         615 non-null    int64   
 9   Collection_Amount (in lakhs) 615 non-null    float64 
 10  Reload_History (per month) 615 non-null    int64   
 11  Sale_Area        615 non-null    object  
 12  Next load_Status 615 non-null    object  
dtypes: float64(4), int64(3), object(6)
memory usage: 62.6+ KB
```

```
In [290...]: # Check column names in the dataset
data.columns
```

```
Out[290...]: Index(['Sale ID ', 'Gender', 'Age (months)', 'Vaccine status', 'Weight(kg)', 'Death Rate(%) ', 'Sale (in lakhs)', 'Profit (%)', 'Risk (%)', 'Collection_Amount (in lakhs)', 'Reload_History (per month)', 'Sale_Area', 'Next load_Status'],
dtype='object')
```

Data Understanding:

- Sale ID : Unique Sale ID
- Gender: Male/Female
- Age (months): Age of the Birds
- Vaccine status: Birds vaccinated status
- Weight(kg): Birds weight
- Death Rate (%): Birds Mortality Rate
- Sale (in lakhs): Birds sale percent
- Profit (%): Profit gained from the Birds
- Risk (%): Risk involved in bringing up the birds
- Collection_Amount (in lakhs): Amount made from the Birds
- Reload_History (per month): Birds re-purchased history
- Sale_Area: Rural/Semi-Urban/Urban
- Next load_Status: Birds plan to reload in next batches status(N/Y).

```
In [291...]: # Check the total unique sale ids
```

```
data['Sale ID '].nunique()
```

Out[291... 615

```
# dropping the unique sale ids  
data.drop(columns=['Sale ID '], inplace=True)
```

```
data.columns
```

```
Index(['Gender', 'Age (months)', 'Vaccine status', 'Weight(kg)',  
       'Death Rate(%)', 'Sale (in lakhs)', 'Profit (%)', 'Risk (%)',  
       'Collection_Amount (in lakhs)', 'Reload_History (per month)',  
       'Sale_Area', 'Next load_Status'],  
      dtype='object')
```

```
# Check the gender types  
data['Gender'].unique()
```

Out[294... array(['Male Bird', 'Female Bird'], dtype=object)

```
# Check the count of each gender types -  
data['Gender'].value_counts()
```

```
Out[295... Gender  
Male Bird      487  
Female Bird     128  
Name: count, dtype: int64
```

```
# Check the age of the birds  
data['Age (months)'].unique()
```

Out[296... array(['5', '4', '1', '0', '3', '12', '4+', '2', '11', '10', '9', '6',
 '7', '8', '14'], dtype=object)

```
#check the counts based on the ages  
data['Age (months)'].value_counts()
```

```
Out[297... Age (months)  
0      149  
1      109  
4      64  
3      46  
7      44  
8      44  
2      41  
5      37  
9      37  
6      22  
11     13  
10     4  
4+     3  
12     1  
14     1  
Name: count, dtype: int64
```

```
In [298... data['Vaccine status'].unique()
```

```
Out[298... array(['Yes', 'No'], dtype=object)
```

```
In [299... data['Vaccine status'].value_counts()
```

```
Out[299... Vaccine status
Yes    391
No     224
Name: count, dtype: int64
```

```
In [300... data['Weight(kg)'].unique()
```

```
Out[300... array([5.   , 0.25 , 0.58 , 4.56 , 0.35 , 0.3  , 0.23 , 0.26 , 1.25 ,
                  0.28 , 3.65 , 1.53 , 6.   , 9.   , 2.   , 0.98 , 0.965, 1.65 ,
                  1.9  , 0.21 , 4.   , 1.96 , 2.3  , 6.25 , 8.96 , 3.36 , 2.39 ,
                  1.12 , 0.78 , 1.99 , 0.287, 1.897, 0.214, 3.89 , 2.2  , 0.32 ,
                  1.98 ])
```

```
In [301... data['Weight(kg)'].value_counts()
```

```
Out[301...]: Weight(kg)
0.214      103
0.780       76
0.210       51
0.287       50
8.960       34
9.000       28
3.360       25
1.990       24
1.897       21
5.000       20
0.250       18
2.200       15
0.980       13
0.320       13
2.390       12
3.890       11
0.350       11
0.965       10
3.650       10
0.280        9
1.900        8
1.530        8
0.580        7
4.560        6
1.980        6
2.300        5
1.250        5
2.000        4
1.120        4
1.960        1
6.250        1
4.000        1
1.650        1
6.000        1
0.260        1
0.230        1
0.300        1
Name: count, dtype: int64
```

```
In [302...]: data['Death Rate(%)'].unique()
```

```
Out[302...]: array([12. , 15. , 15.9, 2. , 2.56, 6. , 10. ])
```

```
In [303...]: data['Death Rate(%)'].value_counts()
```

```
Out[303...]: Death Rate(%)
15.00      347
12.00      166
6.00       85
2.00       14
15.90       1
2.56       1
10.00      1
Name: count, dtype: int64
```

```
In [304... data['Sale (in lakhs)'].unique()
```

```
Out[304... array([98. , 2.75, 69. , 93. , 89. ])
```

```
In [305... data['Sale (in lakhs)'].value_counts()
```

```
Out[305... Sale (in lakhs)
2.75      348
98.00     210
93.00      41
69.00      15
89.00       1
Name: count, dtype: int64
```

```
In [306... data['Collection_Amount (in lakhs)'].unique()
```

```
Out[306... array([14.8 , 2.63, 4.8 , 2.35, 0.85])
```

```
In [307... data['Collection_Amount (in lakhs)'].value_counts()
```

```
Out[307... Collection_Amount (in lakhs)
2.63      367
4.80      217
2.35      25
0.85       5
14.80       1
Name: count, dtype: int64
```

```
In [308... data['Reload_History (per month)'].unique()
```

```
Out[308... array([1, 0], dtype=int64)
```

```
In [309... data['Reload_History (per month)'].value_counts()
```

```
Out[309... Reload_History (per month)
1      526
0      89
Name: count, dtype: int64
```

```
In [310... data['Sale_Area'].unique()
```

```
Out[310... array(['Urban', 'Semiurban', 'Rural'], dtype=object)
```

```
In [311... data['Sale_Area'].value_counts()
```

```
Out[311... Sale_Area
Semiurban    233
Urban        203
Rural        179
Name: count, dtype: int64
```

```
In [312... data['Next load_Status'].unique()
```

```
Out[312... array(['N', 'Y'], dtype=object)
```

```
In [313...]: data['Next_load_Status'].value_counts()
```

```
Out[313...]: Next load_Status  
Y    424  
N    191  
Name: count, dtype: int64
```

Exploratory Data Analysis (EDA)

```
In [314...]: continuos = ['Death Rate(%)', 'Sale (in lakhs)', 'Profit (%)', 'Risk (%)', 'Collection_Amount (in lakhs)']
```

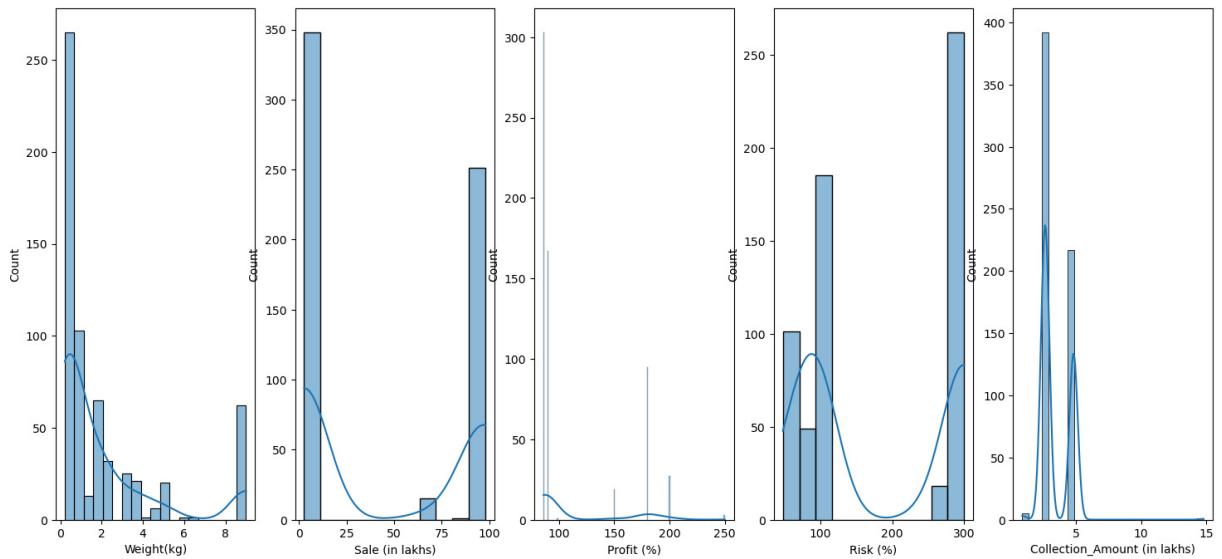
```
In [315...]: continuos = ['Death Rate(%)', 'Sale (in lakhs)', 'Profit (%)', 'Risk (%)', 'Collection_Amount (in lakhs)']  
discrete_categorical = ['Gender', 'Age (months)', 'Vaccine status', 'Sale_Area', 'Relocation_Status']  
discrete_count = ['Weight(kg)', 'Reload_History (per month)']
```

```
In [316...]: data[continous].describe()
```

	Death Rate(%)	Sale (in lakhs)	Profit (%)	Risk (%)	Collection_Amount (in lakhs)
count	615.000000	615.000000	615.000000	615.000000	615.000000
mean	12.623512	43.047154	109.409756	181.952846	3.389610
std	3.483846	46.257078	40.650948	106.377697	1.164683
min	2.000000	2.750000	86.000000	48.000000	0.850000
25%	12.000000	2.750000	86.000000	95.500000	2.630000
50%	15.000000	2.750000	90.000000	100.000000	2.630000
75%	15.000000	98.000000	90.000000	300.000000	4.800000
max	15.900000	98.000000	250.000000	300.000000	14.800000

```
In [317...]: # Histograms with KDE curves  
plt.rcParams['figure.figsize'] = (18,8)  
  
plt.subplot(1,5,1)  
sns.histplot(data['Weight(kg)'], kde=True)  
  
plt.subplot(1,5,2)  
sns.histplot(data['Sale (in lakhs)'], kde=True)  
  
plt.subplot(1,5,3)  
sns.histplot(data['Profit (%)'], kde=True)  
  
plt.subplot(1,5,4)  
sns.histplot(data['Risk (%)'], kde=True)  
  
plt.subplot(1,5,5)  
sns.histplot(data['Collection_Amount (in lakhs)'], kde=True)
```

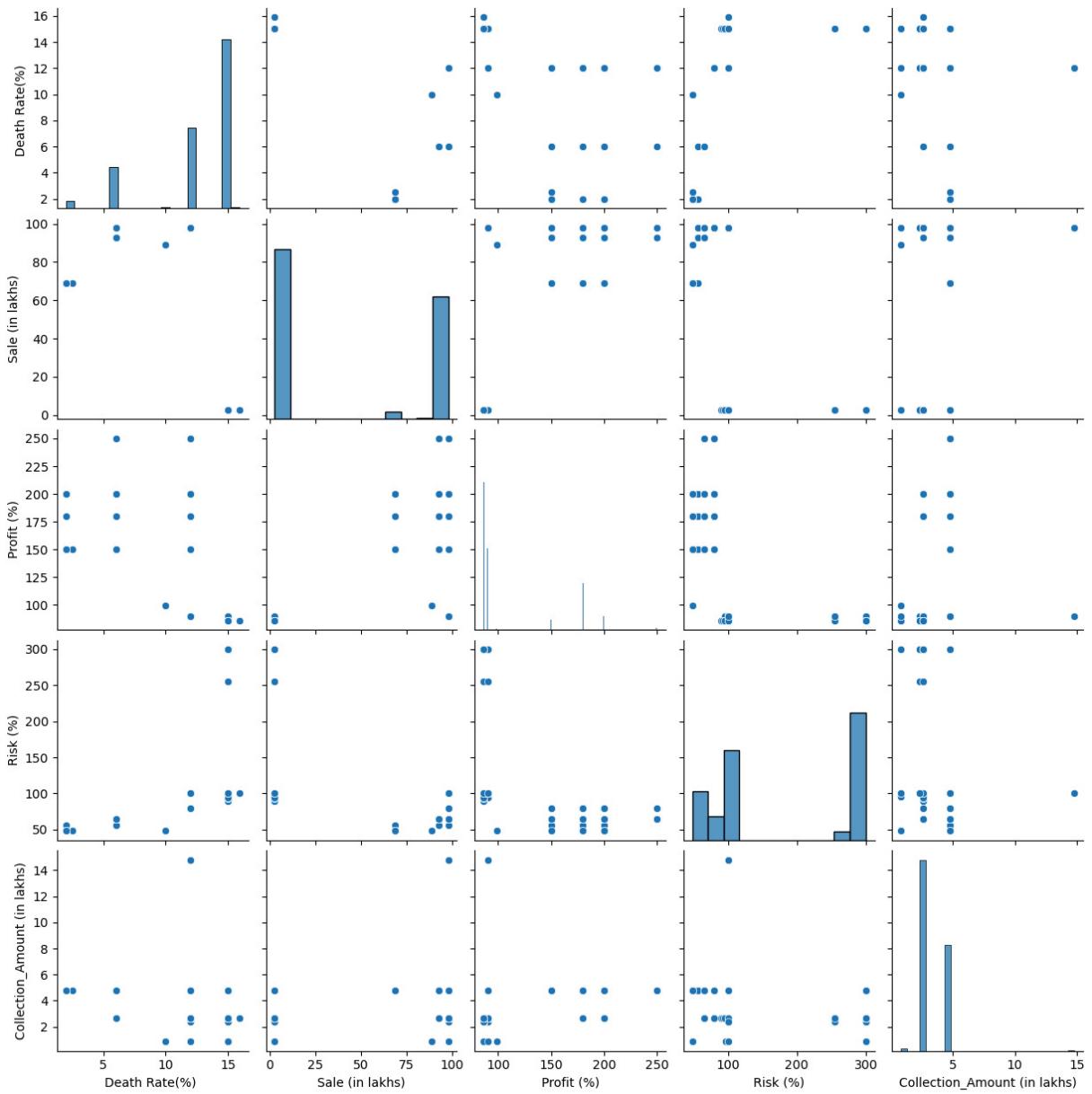
```
Out[317... <Axes: xlabel='Collection_Amount (in lakhs)', ylabel='Count'>
```



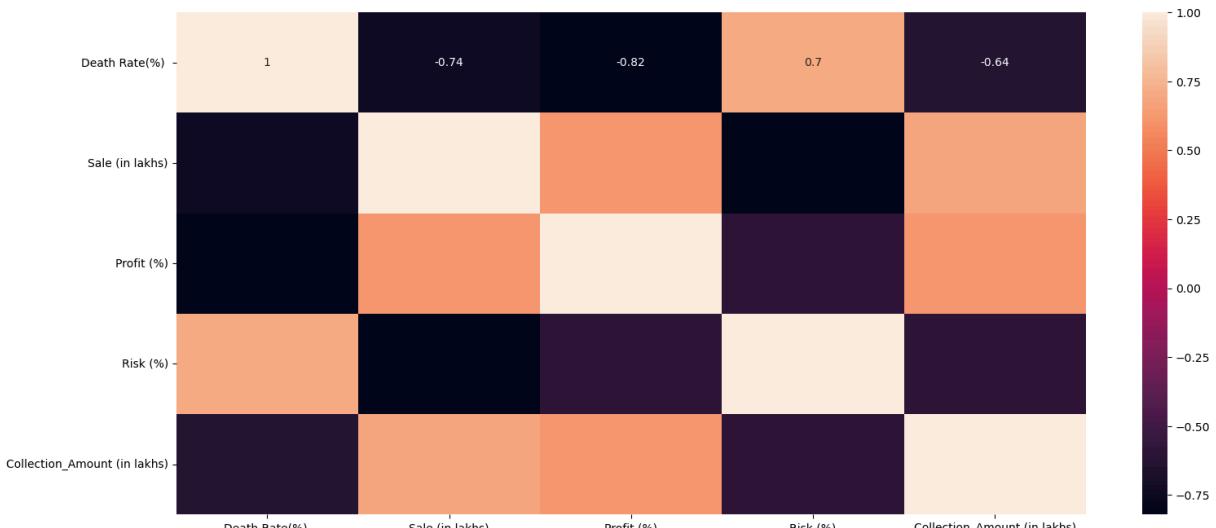
```
In [318... data[continous].skew()
```

```
Out[318... Death Rate(%)           -1.463392
Sale (in lakhs)          0.289672
Profit (%)                1.410468
Risk (%)                  0.149283
Collection_Amount (in lakhs) 1.886005
dtype: float64
```

```
In [319... sns.pairplot(data[continous])
plt.show()
```



```
In [320]: sns.heatmap(data[continuous].corr(), annot=True)
plt.show()
```



```
In [321... # Visualize the outliers using Box Plot

plt.subplot(1,5,1)
sns.boxplot(data['Weight(kg)'])

plt.subplot(1,5,2)
sns.boxplot(data['Sale (in lakhs)'])

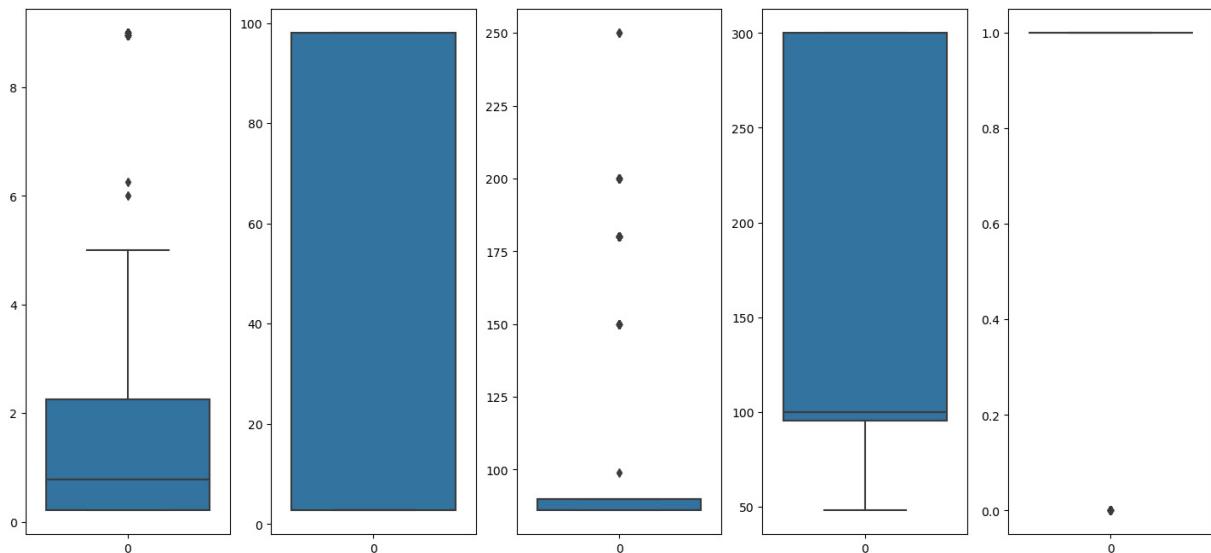
plt.subplot(1,5,3)
sns.boxplot(data['Profit (%)'])

plt.subplot(1,5,4)
sns.boxplot(data['Risk (%)'])

plt.subplot(1,5,5)
sns.boxplot(data['Reload_History (per month)'])

plt.suptitle('Outliers in the Data')
plt.show()
```

Outliers in the Data



for Discrete Variables

```
In [322... # column analysis
continuous = ['Weight(kg)', 'Sale (%)', 'Profit (%)', 'Risk (%)', 'Collection_Amount (in
discrete_categorical = ['Gender', 'Age (months)', 'Vaccine status', 'Sale_Area', 'Next
```

```
In [323... data[discrete_categorical].describe()
```

Out[323...]

	Gender	Age (months)	Vaccine status	Sale_Area	Next load_Status
--	--------	--------------	----------------	-----------	------------------

count	615	615	615	615	615
unique	2	15	2	3	2
top	Male	Bird	0	Yes	Semiurban
freq	487	149	391	233	424

In [324...]

```
# Visualize the outliers using Box Plot
plt.subplot(1,5,1)
sns.boxplot(data['Weight(kg)'])

plt.subplot(1,5,2)
sns.boxplot(data['Sale (in lakhs)'])

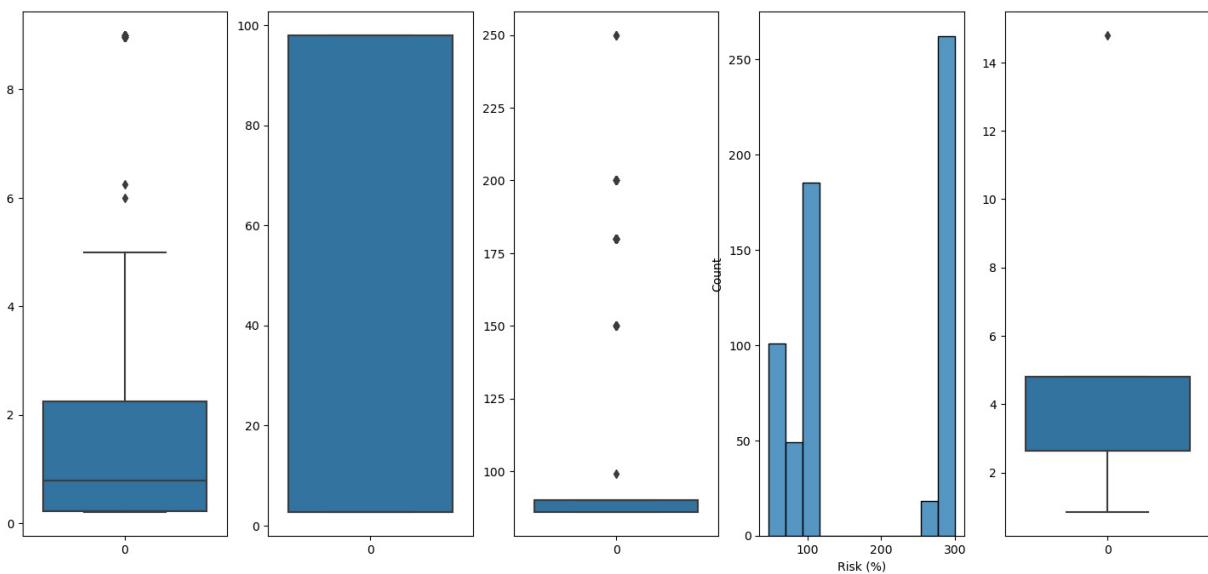
plt.subplot(1,5,3)
sns.boxplot(data['Profit (%)'])

plt.subplot(1,5,4)
sns.histplot(data['Risk (%)'])

plt.subplot(1,5,5)
sns.boxplot(data['Collection_Amount (in lakhs)'])
```

Out[324...]

<Axes: >



Data Preparation:

Modifying the wrong data

In [325...]

```
data['Age (months)'].unique()
```

Out[325...]

```
array(['5', '4', '1', '0', '3', '12', '4+', '2', '11', '10', '9', '6',
       '7', '8', '14'], dtype=object)
```

```
In [326... # converting the 4+ to 4 - as per observing the dataset.  
data['Age (months)'] = data['Age (months)'].replace(['4+'], '4')
```

```
In [327... data['Age (months)'].unique()
```

```
Out[327... array(['5', '4', '1', '0', '3', '12', '2', '11', '10', '9', '6', '7', '8',  
'14'], dtype=object)
```

Missing Values Treatment

```
In [328... # Check number of missing values  
data.isnull().sum()
```

```
Out[328... Gender 0  
Age (months) 0  
Vaccine status 0  
Weight(kg) 0  
Death Rate(%) 0  
Sale (in lakhs) 0  
Profit (%) 0  
Risk (%) 0  
Collection_Amount (in lakhs) 0  
Reload_History (per month) 0  
Sale_Area 0  
Next load_Status 0  
dtype: int64
```

```
In [329... # check percentage of missing values  
data.isnull().sum()/len(data)*100
```

```
Out[329... Gender 0.0  
Age (months) 0.0  
Vaccine status 0.0  
Weight(kg) 0.0  
Death Rate(%) 0.0  
Sale (in lakhs) 0.0  
Profit (%) 0.0  
Risk (%) 0.0  
Collection_Amount (in lakhs) 0.0  
Reload_History (per month) 0.0  
Sale_Area 0.0  
Next load_Status 0.0  
dtype: float64
```

```
In [330... # to make sure thee columns donot have any missing values and donot replace but drop  
data = data.dropna(subset=['Weight(kg)', 'Sale (in lakhs)', 'Reload_History (per mont
```

```
In [331... data.isnull().sum()
```

```
Out[331...]: Gender          0  
Age (months)      0  
Vaccine status    0  
Weight(kg)         0  
Death Rate(%)     0  
Sale (in lakhs)   0  
Profit (%)        0  
Risk (%)          0  
Collection_Amount (in lakhs) 0  
Reload_History (per month)    0  
Sale_Area          0  
Next load_Status   0  
dtype: int64
```

treating Outliers

Encoding

```
In [332...]: data['Gender'] = data['Gender'].map({'Male Bird':1,'Female Bird':0}).astype('int')  
  
In [334...]: data['Vaccine status'] = data['Vaccine status'].map({'Yes':1,'No':0}).astype('int')  
  
In [335...]: data['Sale_Area'] = data['Sale_Area'].map({'Semiurban':0,'Urban':1,'Rural':2}).astype('int')  
  
In [336...]: data['Next load_Status'] = data['Next load_Status'].map({'N':0,'Y':1}).astype('int')
```

Data conversion

```
In [337...]: data['Weight(kg)'] = data['Weight(kg)'].astype('int')  
  
In [344...]: data['Sale (in lakhs)'] = data['Sale (in lakhs)'].astype('int')  
  
In [345...]: data['Age (months)'] = data['Age (months)'].astype('int')  
  
In [346...]: data['Collection_Amount (in lakhs)'] = data['Collection_Amount (in lakhs)'].astype('int')  
  
In [347...]: data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 615 entries, 0 to 614
Data columns (total 13 columns):
 #   Column           Non-Null Count  Dtype  
--- 
 0   Gender            615 non-null    int32  
 1   Age (months)     615 non-null    int32  
 2   Vaccine status    615 non-null    int32  
 3   Weight(kg)       615 non-null    int32  
 4   Death Rate(%)    615 non-null    float64 
 5   Sale (in lakhs)  615 non-null    int32  
 6   Profit (%)        615 non-null    int64  
 7   Risk (%)          615 non-null    int64  
 8   Collection_Amount (in lakhs) 615 non-null    int32  
 9   Reload_History (per month)  615 non-null    int64  
 10  Sale_Area         615 non-null    int32  
 11  Next load_Status  615 non-null    int32  
 12  Sale (%)          615 non-null    int32  
dtypes: float64(1), int32(9), int64(3)
memory usage: 41.0 KB
```

Transformation

```
In [348...]: data[['Weight(kg)', 'Profit (%)']].skew() # no skewness
```

```
Out[348...]: Weight(kg)    1.822597
Profit (%)     1.410468
dtype: float64
```

```
In [349...]: data
```

Out[349...]

	Gender	Age (months)	Vaccine status	Weight(kg)	Death Rate(%)	Sale (in lakhs)	Profit (%)	Risk (%)	Collection_Amc (in lakhs)
0	1	5	1	5	12.0	98	90	100	
1	0	4	1	0	15.0	2	86	100	
2	1	1	1	0	15.9	2	86	100	
3	1	0	1	0	15.0	2	86	100	
4	0	3	1	0	15.0	2	90	100	
...
610	1	2	0	0	15.0	2	86	300	
611	1	2	0	0	15.0	2	86	300	
612	1	2	0	0	15.0	2	86	300	
613	0	5	0	1	12.0	98	90	100	
614	1	2	0	0	15.0	2	86	300	

615 rows × 13 columns



X & y

In [350...]

```
X = data.drop('Next_load_Status', axis=1)
y = data['Next_load_Status']
```

Identify the best random state number

In [352...]

```
Train = []
Test = []
CV = []

for i in range(0,101):
    from sklearn.model_selection import train_test_split
    X_train, X_test, y_train, y_test = train_test_split(X,y,test_size=0.2, random_state=i)

    from sklearn.linear_model import LogisticRegression
    log_default = LogisticRegression()
    log_default.fit(X_train,y_train)

    ypred_train = log_default.predict(X_train)
    ypred_test = log_default.predict(X_test)

    from sklearn.metrics import accuracy_score
    Train.append(accuracy_score(y_train,ypred_train))
    Test.append(accuracy_score(y_test,ypred_test))
```

```

from sklearn.model_selection import cross_val_score
CV.append(cross_val_score(log_default, X_train, y_train, cv=5, scoring="accuracy")

em = pd.DataFrame({"Train":Train, "Test":Test, "CV":CV})
gm = em[(abs(em['Train']-em['Test'])<=0.05) & (abs(em['Test']-em['CV'])<=0.05)]
rs = gm[gm["CV"]==gm["CV"].max()].index.to_list()[0]
print("best random_state number:",rs)

```

best random_state number: 65

train-test split

```
In [355...]: from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size = 0.2, random_s
```

Machine Learning Modelling & Evaluation

1. Logistic Regression

```
In [435...]: from sklearn.linear_model import LogisticRegression
log_model = LogisticRegression()
log_model.fit(X_train,y_train)

ypred_train = log_model.predict(X_train)
ypred_test = log_model.predict(X_test)

print("Train Accuracy : ",accuracy_score(y_train,ypred_train))
print("Cross validation score : ", cross_val_score(log_model,X_train,y_train, cv=5, sc
print("Test Accuracy : ",accuracy_score(y_test,ypred_test))
```

Train Accuracy : 0.8252032520325203
Cross validation score : 0.8231704803133374
Test Accuracy : 0.7804878048780488

2. KNN

```
In [436...]: from sklearn.neighbors import KNeighborsClassifier

estimator = KNeighborsClassifier()
param_grid = {'n_neighbors': list(range(1,50))}

from sklearn.model_selection import GridSearchCV
knn_grid = GridSearchCV(estimator, param_grid, scoring='accuracy', cv=5)
knn_grid.fit(X_train,y_train)

knn_model = knn_grid.best_estimator_

ypred_train = knn_model.predict(X_train)
ypred_test = knn_model.predict(X_test)

print("Train Accuracy : ", accuracy_score(y_train,ypred_train))
```

```
print("Cross validation score :", cross_val_score(knn_model,X_train,y_train,cv=5,sc
print("Test Accuracy :", accuracy_score(y_test,ypred_test))
```

Train Accuracy : 0.7926829268292683
Cross validation score : 0.75007215007215
Test Accuracy : 0.6422764227642277

In [358...]: knn_grid.best_estimator_

Out[358...]:

```
▼ KNeighborsClassifier  
KNeighborsClassifier(n_neighbors=7)
```

3. Support Vector Machine (SVM)

In [438...]:

```
from sklearn.svm import SVC

estimator = SVC()
param_grid = {'C':[0.01,0.1,1], 'kernel':['linear','rbf','sigmoid','poly']}

from sklearn.model_selection import GridSearchCV
svm_grid = GridSearchCV(estimator, param_grid, scoring='accuracy', cv=5)
svm_grid.fit(X_train,y_train)

svm_model = svm_grid.best_estimator_

ypred_train = svm_model.predict(X_train)
ypred_test = svm_model.predict(X_test)

print("Train Accuracy :", accuracy_score(y_train,ypred_train))
print("Cross validation score :", cross_val_score(svm_model,X_train,y_train,cv=5,sc
print("Test Accuracy :", accuracy_score(y_test,ypred_test))
```

Train Accuracy : 0.8211382113821138
Cross validation score : 0.8211502782931355
Test Accuracy : 0.7723577235772358

In [369...]: svm_grid.best_estimator_

4. Decision Tree Classifier

In [404...]:

```
from sklearn.tree import DecisionTreeClassifier
estimator = DecisionTreeClassifier(random_state=rs)
param_grid = {"criterion":["gini","entropy"],
             "max_depth":list(range(1,16))}

from sklearn.model_selection import GridSearchCV
dt_grid = GridSearchCV(estimator,param_grid, scoring='accuracy', cv=5)
dt_grid.fit(X_train,y_train)
```

```
Out[404...          GridSearchCV
      ▶ estimator: DecisionTreeClassifier
          ▶ DecisionTreeClassifier
```

```
In [405... # storing at dt
      dt = dt_grid.best_estimator_
```

```
In [406... dt.feature_importances_
```

```
Out[406... array([0., 0., 0., 0., 0., 0., 0., 0., 1., 0., 0.])
```

```
In [407... dt_fi = dt.feature_importances_
```

```
In [410... # only index number 9 is important
      list(enumerate(dt_fi))
```

```
Out[410... [(0, 0.0),
            (1, 0.0),
            (2, 0.0),
            (3, 0.0),
            (4, 0.0),
            (5, 0.0),
            (6, 0.0),
            (7, 0.0),
            (8, 0.0),
            (9, 1.0),
            (10, 0.0),
            (11, 0.0)]
```

```
In [399... X_train
```

Out[399...]

Gender	Age (months)	Vaccine status	Weight(kg)	Death Rate(%)	Sale (in lakhs)	Profit (%)	Risk (%)	Collection_Amc (in lakhs)
165	1	5	1	9	12.0	98	90	100
32	1	0	1	0	15.0	2	86	300
314	1	9	1	3	6.0	93	180	65
601	1	0	0	0	15.0	2	86	100
142	1	2	1	0	15.0	2	86	300
...
184	1	4	1	9	12.0	98	90	100
327	1	8	1	1	6.0	98	180	65
296	1	1	1	0	15.0	2	86	300
575	1	8	0	2	6.0	98	180	65
117	0	11	1	3	2.0	69	200	48

492 rows × 12 columns



In [411...]

X_train_dt = X_train.iloc[:,index]

In [413...]

X_train_dt # showing only the important column

Out[413...]

Reload_History (per month)

165	1
32	1
314	1
601	0
142	1
...	...
184	1
327	0
296	1
575	1
117	1

492 rows × 1 columns

```
In [422...]  

from sklearn.tree import DecisionTreeClassifier  

estimator = DecisionTreeClassifier(random_state=rs)  

param_grid = {"criterion":["gini","entropy"],  

             "max_depth":list(range(1,16))}  

from sklearn.model_selection import GridSearchCV  

dt_grid = GridSearchCV(estimator,param_grid, scoring='accuracy',cv=5)  

dt_grid.fit(X_train,y_train)  

dt = dt_grid.best_estimator_  

dt_fi = dt.feature_importances_  

#identify the features where the feature importance is >0.  

index =[i for i,x in enumerate(dt_fi) if x >0]  

#create new dataset with important features  

X_train_dt = X_train.iloc[:,index]  

X_test_dt = X_test.iloc[:,index]  

# train with best model & with important features  

dt.fit(X_train_dt,y_train)  

ypred_train = dt.predict(X_train_dt)  

ypred_test = dt.predict(X_test_dt)  

#Evaluate the best model  

print("Train Accuracy : ", accuracy_score(y_train,ypred_train))  

print("Cross validation score : ", cross_val_score(svm_model,X_train,y_train,cv=5,sc  

print("Test Accuracy : ", accuracy_score(y_test,ypred_test))
```

Train Accuracy : 0.8211382113821138
Cross validation score : 0.8211502782931355
Test Accuracy : 0.7723577235772358

In [423...]
dt_grid.best_estimator_

Out[423...]
▼ DecisionTreeClassifier

DecisionTreeClassifier(max_depth=1, random_state=65)

In [424...]
future importances
dt.feature_importances_

Out[424...]
array([1.])

5. Random Forest Classifier

1. Apply hyper parametr tuning and identify the best model

2. using the best model - identify importance of each feature
3. From features identify the importance features where the feature importance value is > 0.

```
In [426...]
from sklearn.ensemble import RandomForestClassifier
estimator = RandomForestClassifier(random_state=rs)
param_grid = {"criterion":["gini","entropy"],
              "max_depth":list(range(1,16))}

from sklearn.model_selection import GridSearchCV
dt_grid = GridSearchCV(estimator,param_grid, scoring='accuracy',cv=5)
dt_grid.fit(X_train,y_train)

dt = dt_grid.best_estimator_
dt_fi = dt.feature_importances_

#identify the features where the feature importance is >0.

index =[i for i,x in enumerate(dt_fi) if x >0]

#create new dataset with important features

X_train_dt = X_train.iloc[:,index]
X_test_dt = X_test.iloc[:,index]

# train with best model & with important features

dt.fit(X_train_dt,y_train)

ypred_train = dt.predict(X_train_dt)
ypred_test = dt.predict(X_test_dt)

#Evaluate the best model

print("Train Accuracy :", accuracy_score(y_train,ypred_train))
print("Cross validation score :", cross_val_score(svm_model,X_train,y_train,cv=5,sc
print("Test Accuracy :", accuracy_score(y_test,ypred_test))
```

Train Accuracy : 0.823170731707317
 Cross validation score : 0.8211502782931355
 Test Accuracy : 0.7723577235772358

6. AdaBoost Classifier

```
In [429...]
from sklearn.ensemble import AdaBoostClassifier
estimator = AdaBoostClassifier(random_state=rs)
param_grid = {"n_estimators":list(range(1,51))}

from sklearn.model_selection import GridSearchCV
ab_grid = GridSearchCV(estimator,param_grid, scoring='accuracy',cv=5)
ab_grid.fit(X_train,y_train)
```

```

ab = ab_grid.best_estimator_
ab_fi = ab.feature_importances_

#identify the features where the feature importance is >0.

index =[i for i,x in enumerate(ab_fi) if x >0]

#create new dataset with important features

X_train_ab = X_train.iloc[:,index]
X_test_ab = X_test.iloc[:,index]

# train with best model & with important features

ab.fit(X_train_ab,y_train)

ypred_train = ab.predict(X_train_ab)
ypred_test = ab.predict(X_test_ab)

#Evaluate the best model

print("Train Accuracy :", accuracy_score(y_train,ypred_train))
print("Cross validation score :", cross_val_score(ab,X_train_ab,y_train,cv=5,scoring='accuracy'))
print("Test Accuracy :", accuracy_score(y_test,ypred_test))

```

Train Accuracy : 0.8211382113821138
 Cross validation score : 0.8211502782931355
 Test Accuracy : 0.7723577235772358

7. Gradient Boost Classifier

```

In [431...]: from sklearn.ensemble import GradientBoostingClassifier
estimator = GradientBoostingClassifier(random_state=rs)
param_grid = {"n_estimators":list(range(1,10)), "learning_rate": [0.1,0.2,0.3,0.4,0.5]}

from sklearn.model_selection import GridSearchCV
gb_grid = GridSearchCV(estimator,param_grid, scoring='accuracy',cv=5)
gb_grid.fit(X_train,y_train)

gb = gb_grid.best_estimator_
gb_fi = gb.feature_importances_

#identify the features where the feature importance is >0.

index =[i for i,x in enumerate(gb_fi) if x >0]

#create new dataset with important features

X_train_gb = X_train.iloc[:,index]
X_test_gb = X_test.iloc[:,index]

# train with best model & with important features

```

```

gb.fit(X_train_gb,y_train)

ypred_train = gb.predict(X_train_gb)
ypred_test = gb.predict(X_test_gb)

#Evaluate the best model

print("Train Accuracy :", accuracy_score(y_train,ypred_train))
print("Cross validation score :", cross_val_score(gb,X_train_gb,y_train,cv=5,scoring='accuracy'))
print("Test Accuracy :", accuracy_score(y_test,ypred_test))

```

Train Accuracy : 0.8434959349593496
 Cross validation score : 0.8150896722325294
 Test Accuracy : 0.7479674796747967

8. XGBoost Classifier

In [434...]

```

from xgboost import XGBClassifier
estimator = XGBClassifier(random_state=rs)
param_grid = {"n_estimators": [10, 20, 40, 100], 'max_depth': [3, 4, 5], 'gamma': [0, 0.15, 0.3]}

from sklearn.model_selection import GridSearchCV
xgb_grid = GridSearchCV(estimator, param_grid, scoring='accuracy', cv=5)
xgb_grid.fit(X_train,y_train)

xgb = xgb_grid.best_estimator_
xgb_fi = xgb.feature_importances_

#identify the features where the feature importance is >0.

index =[i for i,x in enumerate(xgb_fi) if x >0]

#create new dataset with important features

X_train_xgb = X_train.iloc[:,index]
X_test_xgb = X_test.iloc[:,index]

# train with best model & with important features

xgb.fit(X_train_xgb,y_train)

ypred_train = xgb.predict(X_train_xgb)
ypred_test = xgb.predict(X_test_xgb)

#Evaluate the best model

print("Train Accuracy :", accuracy_score(y_train,ypred_train))
print("Cross validation score :", cross_val_score(xgb,X_train_xgb,y_train,cv=5,scoring='accuracy'))
print("Test Accuracy :", accuracy_score(y_test,ypred_test))

```

```
Train Accuracy : 0.8211382113821138
Cross validation score : 0.8191300762729334
Test Accuracy : 0.7804878048780488
```

Find the best model

Decision Tree Classifier looks good considering its features and accuracies

```
Train Accuracy : 0.8211382113821138 Cross validation score : 0.8211502782931355 Test
Accuracy : 0.7723577235772358
```

In []: