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Logistic Regression Model to Predict CKD

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Abstract: Artificial intelligence (AI) aims to impersonate human cognitive functions. It is bringing a paradigm shift to healthcare, powered by increasing availability of healthcare data and rapid progress of analytic techniques. Chronic Kidney Disease (CKD) damages the kidneys. Kidneys have the capability to eliminate waste from the body. If this situation occurs, the waste gets accumulated in the body. Chronic Kidney Disease (CKD) is one ailment which could devastate the human body. It can be prevented via examining few indicators like RBC count, specific gravity value, Blood Pressure (BP), albumin levels in urine, sugar content, anaemia and WBC count. Other conditions like coronary artery disease, Diabetes Mellitus (DM) and bacterial infections could directly affect the kidneys. [1] In this paper we have collected few samples from a public hospital and selected fields have been analysed for designing a prediction model for CKD. Data analysis and visualization are carried out to improve the statistical analysis of given data. Before AI systems can be deployed in health-care applications, they need to be 'trained' through data that are generated from clinical activities, such as screening, diagnosis, treatment assignment and so on, so that they can learn similar groups of subjects, associations between subject features and outcomes of interest. Logistic regression is carried out on the data since it contains lot of columns with categorical values. Accuracy, precision, and f1 score of the model have been measured. Various conclusions can be drawn from this interdependent data set and can be stored as historical data for future analysis.

Keywords: Chronic Kidney Disease (CKD), RBC count, specific gravity value, Blood Pressure (BP), albumin levels in urine, sugar content, anaemia, WBC count, Logistic regression, accuracy, precision, and f1 score, coronary artery disease, Diabetes Mellitus (DM) and bacterial infections, categorical values, data analysis and visualization.

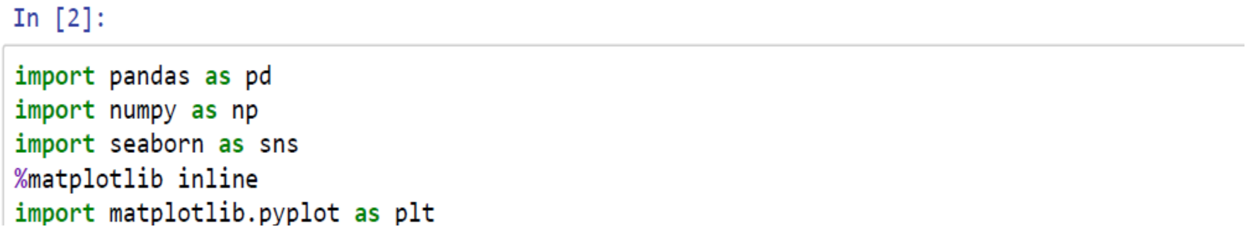
I. INTRODUCTION

We have identified several factors contributing to the failure of kidneys. Few of the listed fields are

i. Age
ii. Blood Pressure (BP)
iii. Specific gravity
iv. Albumin levels in urine
v. Diabetes Mellitus
vi. RBC count, WBC count, pus cell and packed cell volume
vii. Presence or absence of hypertension, coronary artery disease and pedal edema

II. PROBLEM STATEMENT

Data has been collected from a hospital in Madurai. Many patients showing possible symptoms of kidney disease were subjected to various tests and data recorded by the hospital staff. The data set may contain missing values and data pre-processing needs to be carried out on missing values, redundant data and non-numerical values. Data analysis and visualization needs to be carried out to improve the statistical analysis of given data. Logistic regression to create a prediction model for detecting Chronic Kidney Disease, for real-time samples. 'Heatmap' to be plotted for understanding the correlation.



```
In [2]:

import pandas as pd
import numpy as np
import seaborn as sns
%matplotlib inline
import matplotlib.pyplot as plt
```

Figure 1 shows the Python code to import libraries.

III. METHODOLOGY

A. Importing Libraries [2]

Figure 1 shows the Python code to import libraries. We have used three libraries

- ‘numpy’ is a package for scientific computing with Python. This library is imported as ‘np’ and will be used throughout the project.
- ‘pandas’ is for data manipulation and analysis. panadas is an open source, BSD- licenced library providing easy-to-use data structures and data analysis tools. pandas is imported as pd.
- ‘matplotlib.pyplot’ is a collection of command style functions that make matplotlib work like MATLAB. It is imported as plt
- ‘seaborn’ is a Python data visualization library based on matplotlib for attractive and informative statistical graphics.

B. Importing data

Figure 2 shows the Python code to import data from respective directory/ file and assigning it to DataFrame df. The data stored in CSV format is being imported. [3] [4]

C. Checking for NaN

It is very essential in data pre-processing to check for NaN. Figure 3 shows the Python code to check for NaN. In this attempt we could identify few NaN.

D. Manipulating NaN values

It is essential to remove the NaN values. This can be done by

- Removing the entire column containing many NaN values
- Forward fillna method [5]
- Backward fillna method
- Mean method

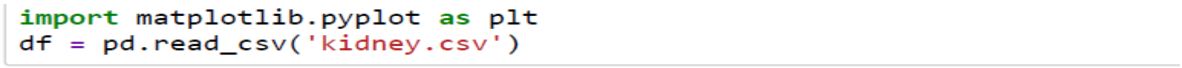
Figure 4 shows the technique of forward fillna method and figure 5 shows the method of dropping the column.

E. Plotting a Heatmap

Correlation between the fields of the recorded data is analysed by plotting a heatmap. The values may be negative or positive and the magnitude plays a key role in designing various predictive models in AI. Figure 6 shows a heatmap and correlation model.

F. Splitting the data into train and test sets. Figure 7 shows the python code to split the data set into train and test data.

G. Applying logistic regression on the split data. Figure 8 shows logistic regression on given data set.



```
import matplotlib.pyplot as plt
df = pd.read_csv('kidney.csv')
```

Figure 2 shows the Python code to import data and assigning it to DataFrame df

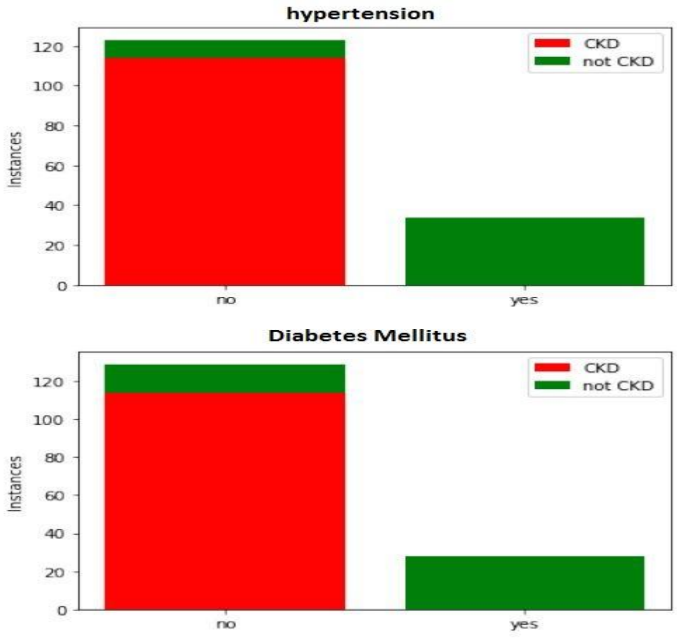
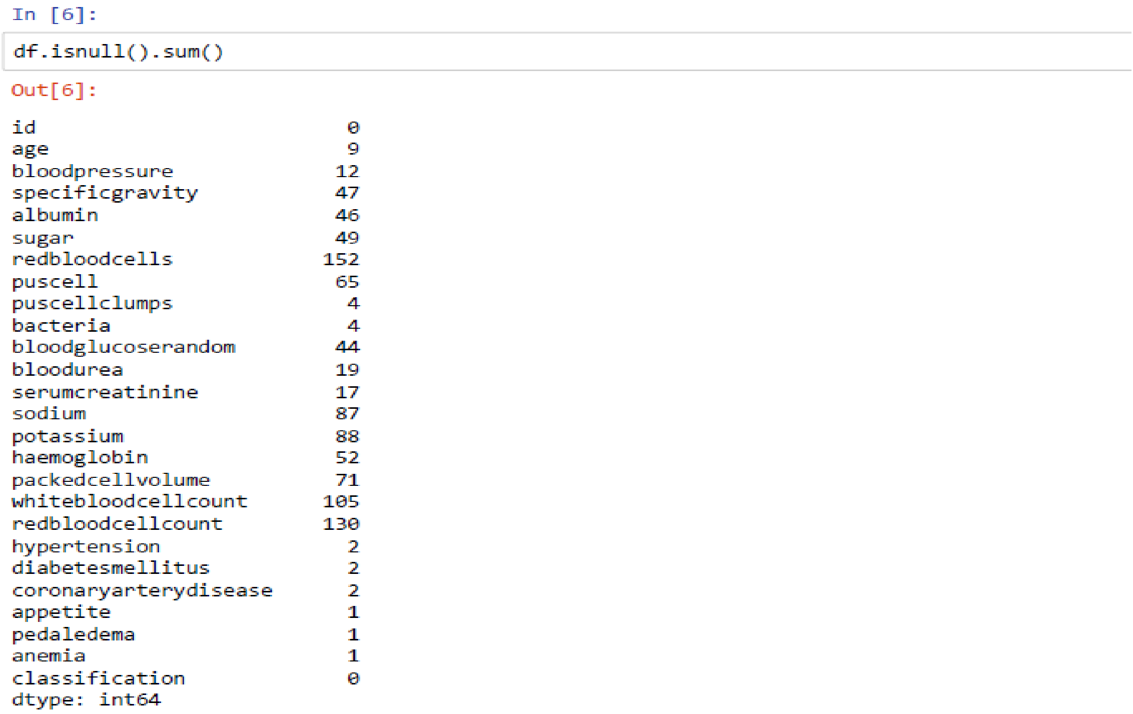
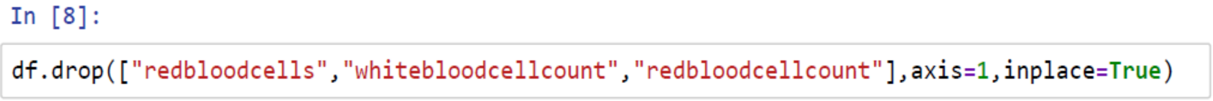


Figure 11 includes data visualization of the dataset



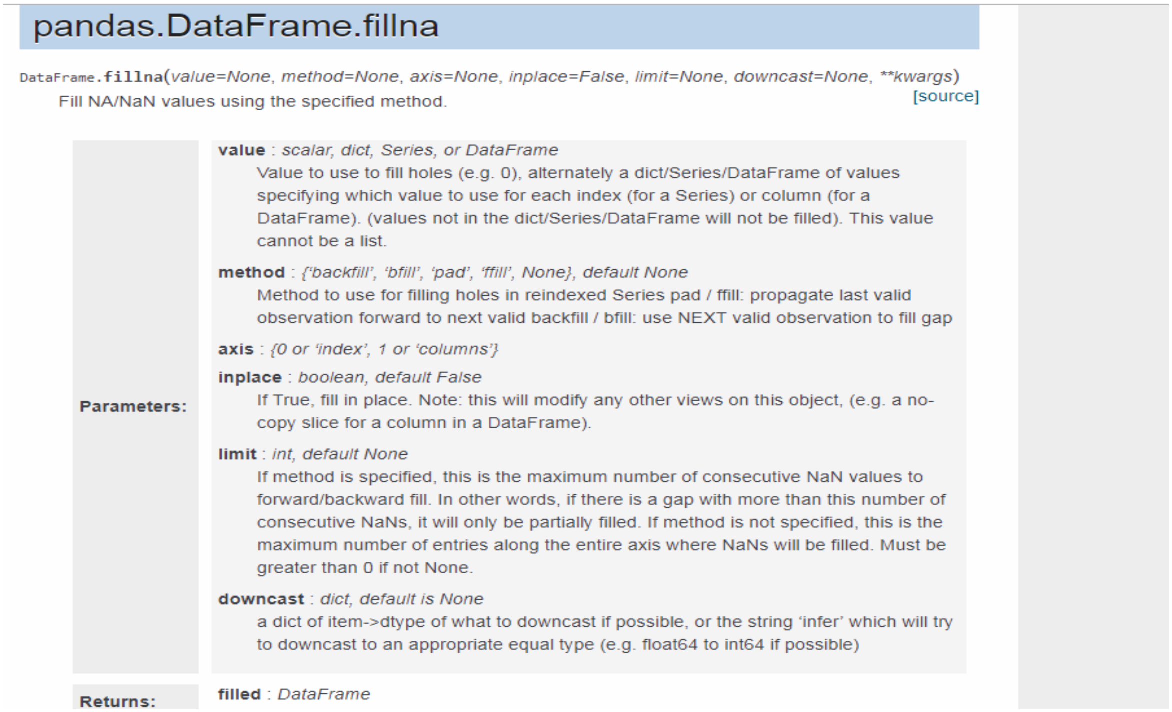
```
In [6]:
df.isnull().sum()
Out[6]:
id                        0
age                       9
bloodpressure            12
specificgravity          47
albumin                  46
sugar                    49
redbloodcells           152
puscell                  65
puscellclumps             4
bacteria                  4
bloodglucoserandom       44
bloodurea                19
serumcreatinine          17
sodium                   87
potassium                88
haemoglobin              52
packedcellvolume         71
whitebloodcellcount     105
redbloodcellcount       130
hypertension              2
diabetesmellitus          2
coronaryarterydisease     2
appetite                  1
pedaledema                1
anemia                    1
classification            0
dtype: int64
```

Figure 3 shows the Python code to check for NaN.



```
In [8]:
df.drop(["redbloodcells","whitebloodcellcount","redbloodcellcount"],axis=1,inplace=True)
```

Figure 5 shows the method of dropping the column



pandas.DataFrame.fillna

`DataFrame.fillna(value=None, method=None, axis=None, inplace=False, limit=None, downcast=None, **kwargs)` [source]

Fill NA/NaN values using the specified method.

Parameters:

value : *scalar, dict, Series, or DataFrame*
Value to use to fill holes (e.g. 0), alternately a dict/Series/DataFrame of values specifying which value to use for each index (for a Series) or column (for a DataFrame). (values not in the dict/Series/DataFrame will not be filled). This value cannot be a list.

method : *{'backfill', 'bfill', 'pad', 'ffill', None}, default None*
Method to use for filling holes in reindexed Series pad / ffill: propagate last valid observation forward to next valid backfill / bfill: use NEXT valid observation to fill gap

axis : *{0 or 'index', 1 or 'columns'}*

inplace : *boolean, default False*
If True, fill in place. Note: this will modify any other views on this object, (e.g. a no-copy slice for a column in a DataFrame).

limit : *int, default None*
If method is specified, this is the maximum number of consecutive NaN values to forward/backward fill. In other words, if there is a gap with more than this number of consecutive NaNs, it will only be partially filled. If method is not specified, this is the maximum number of entries along the entire axis where NaNs will be filled. Must be greater than 0 if not None.

downcast : *dict, default is None*
a dict of item->dtype of what to downcast if possible, or the string 'infer' which will try to downcast to an appropriate equal type (e.g. float64 to int64 if possible)

Returns:

filled : *DataFrame*

Figure 4 shows the technique of forward fillna method

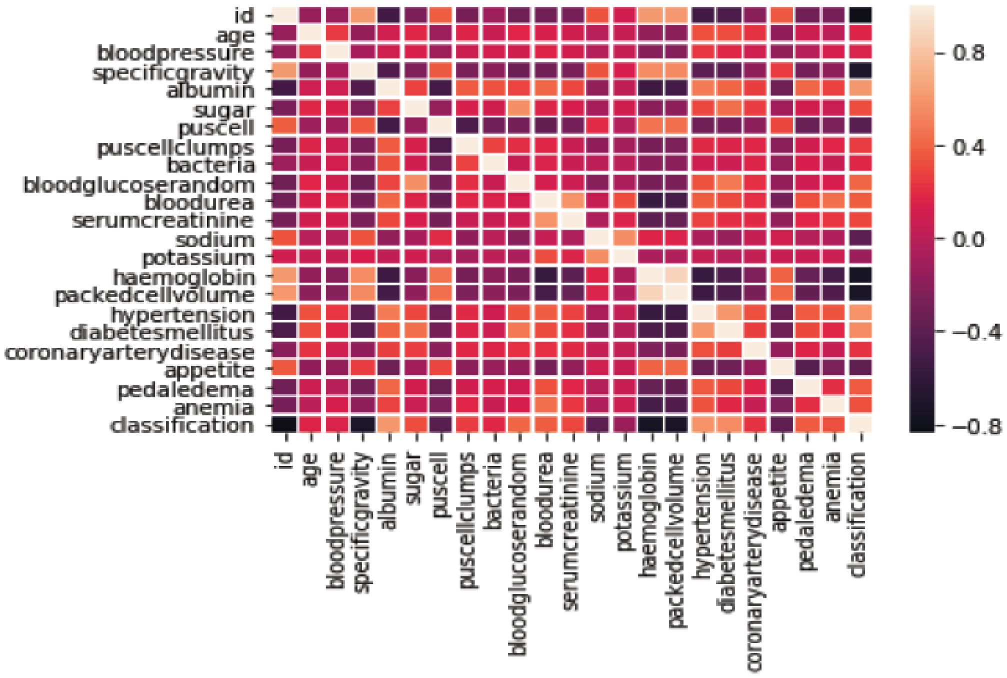
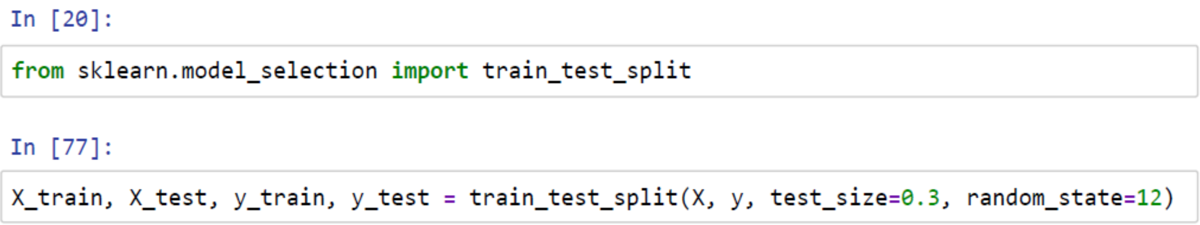


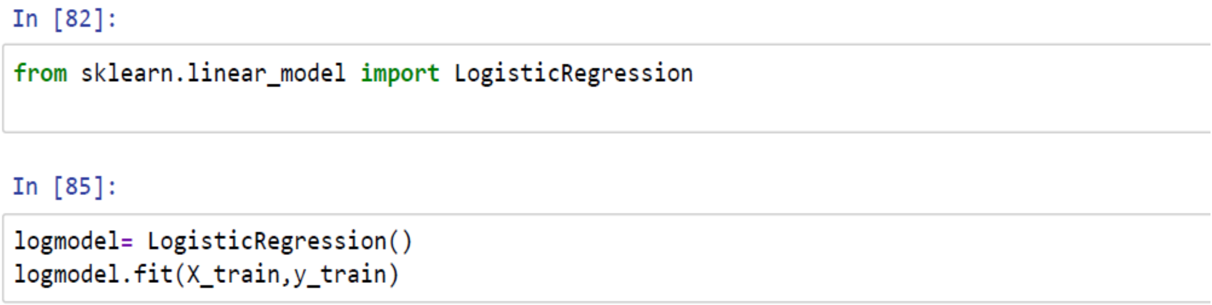
Figure 6 shows a heatmap and correlation model.



```
In [20]:
from sklearn.model_selection import train_test_split

In [77]:
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3, random_state=12)
```

Figure 7 shows the python code to split the data set into train and test data.



```
In [82]:
from sklearn.linear_model import LogisticRegression

In [85]:
logmodel= LogisticRegression()
logmodel.fit(X_train,y_train)
```

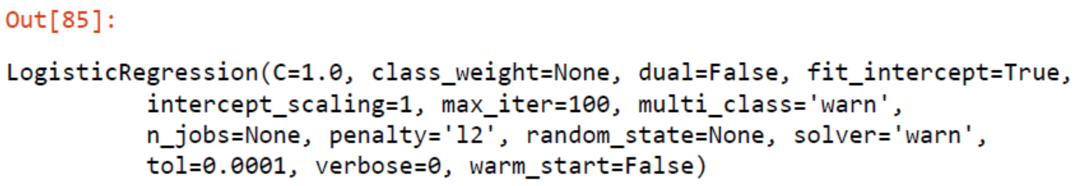
Figure 8 shows logistic regression on given data set.

IV. Data Visualization

Data visualization is an integral part of data analytics and Machine Learning. When there is a huge data set, manual analytics becomes almost impossible. Data visualization plays a vital role in analysis in such situation. It involves use of various plots – bar graph, pie charts, box plots, line graphs and many more. A graph is best when the message is contained in the shape of the values revealing relationships among multiple values (similarities and differences) in case of huge data sets.

V. Results

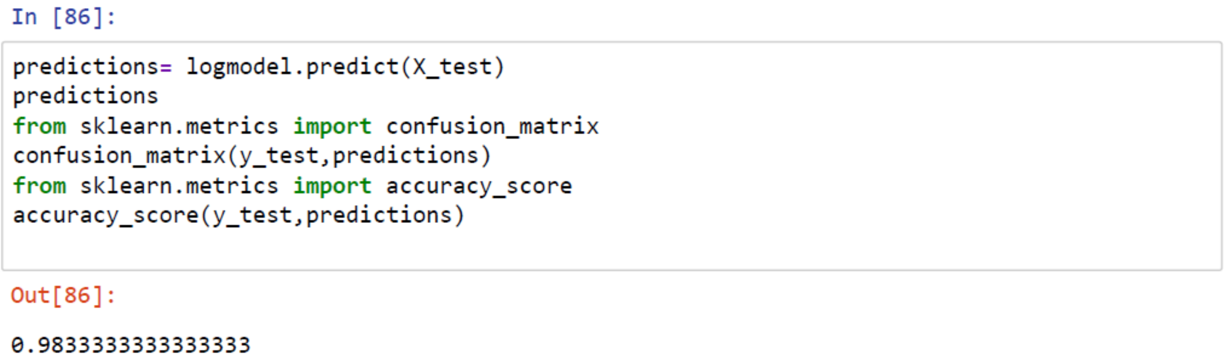
After analysing the heatmap and figuring out the correlation between different columns/ physiological parameters, Logistic regression needs to be carried out to create a prediction model. Figure 9 shows the results of logistic regression model. Figure 10 shows the Accuracy score of the designed model. From this data, precision, f1 score and reliability can be calculated. According to figure 11, all diabetics or patients with High BP may not have CKD, but DM and high BP are the major catalysts for renal failure and occurance of CKD.



```
Out[85]:

LogisticRegression(C=1.0, class_weight=None, dual=False, fit_intercept=True,
          intercept_scaling=1, max_iter=100, multi_class='warn',
          n_jobs=None, penalty='l2', random_state=None, solver='warn',
          tol=0.0001, verbose=0, warm_start=False)
```

Figure 9 shows the results of logistic regression model



```
In [86]:

predictions= logmodel.predict(X_test)
predictions
from sklearn.metrics import confusion_matrix
confusion_matrix(y_test,predictions)
from sklearn.metrics import accuracy_score
accuracy_score(y_test,predictions)

Out[86]:

0.9833333333333333
```

Figure 10 shows the Accuracy score of the designed model.

VI. CONCLUSIONS

Chronic Kidney Disease is fatal, but can be treated and cured when identified at an early stage. Few samples were considered to design a predictive model using Logistic Regression. The data set was taken from a trusted source, pre-processed, statistically analysed and graphs plotted. A heatmap was plotted to identify the correlation between different fields of interest. The data being cleansed (removing NaN values) was subjected to division as train and test data. 70% of the data was fed for training and the remaining considered for test. We have calculated the accuracy of the model and were happy to conclude with 98.33% accuracy. Any new samples taken can be predicted with this model with high reliability, accuracy and precision.

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BIOGRAPHY

VISHESH S born on 13th June 1992, hails from Bangalore (Karnataka) and has completed B.E in Telecommunication Engineering from VTU, Belgaum, Karnataka in 2015. He also worked as an intern under Dr. Shivananju BN, former Research Scholar, Department of Instrumentation, IISc, Bangalore. His research interests include Embedded Systems, Wireless Communication, BAN and Medical Electronics. He is also the Founder and Managing Director of the corporate company Konigtronics Private Limited. He has guided over a hundred students/interns/professionals in their research work and projects. He is also the co-author of many International Research Papers. He is currently pursuing his MBA in e-Business and PG Diploma in International Business. Presently Konigtronics Private Limited has extended its services in the field of Software Engineering and Webpage Designing. Konigtronics also conducts technical and non-technical workshops on various topics.