Problem Statement 7

Paleti Krishnasai - CED18I039

Question 1:

1. Implement the Naïve Bayes Classifier on the below given dataset. Test record for the given dataset is (Rainy, Cool, Normal, True). Also test the same on a large dataset with a sample test record.

In [1]:

```
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
from sklearn.naive_bayes import GaussianNB
```

In [2]:

```
golf_df=pd.read_csv("golf-dataset.csv")
golf_df
```

Out[2]:

	Outlook	Temp	Humidity	Windy	Play Golf
0	Rainy	Hot	High	False	No
1	Rainy	Hot	High	True	No
2	Overcast	Hot	High	False	Yes
3	Sunny	Mild	High	False	Yes
4	Sunny	Cool	Normal	False	Yes
5	Sunny	Cool	Normal	True	No
6	Overcast	Cool	Normal	True	Yes
7	Rainy	Mild	High	False	No
8	Rainy	Cool	Normal	False	Yes
9	Sunny	Mild	Normal	False	Yes

	Outlook	Temp	Humidity	Windy	Play Golf
10	Rainy	Mild	Normal	True	Yes
11	Overcast	Mild	High	True	Yes
12	Overcast	Hot	Normal	False	Yes

In [3]:

```
golf_df.loc[len(golf_df)]=['Rainy','Cool','Normal',True,'No']
```

In [4]:

```
train_x=golf_df.iloc[:,[0,1,2,3]].values
train_y=golf_df.iloc[:,-1].values
```

In [5]:

```
train_x
```

Out[5]:

```
array([['Rainy', 'Hot', 'High', False],
       ['Rainy', 'Hot', 'High', True],
       ['Overcast', 'Hot', 'High', False],
       ['Sunny', 'Mild', 'High', False],
       ['Sunny', 'Cool', 'Normal', False],
       ['Sunny', 'Cool', 'Normal', True],
       ['Overcast', 'Cool', 'Normal', True],
       ['Rainy', 'Mild', 'High', False],
       ['Rainy', 'Cool', 'Normal', False],
       ['Sunny', 'Mild', 'Normal', False],
       ['Rainy', 'Mild', 'Normal', True],
       ['Overcast', 'Mild', 'High', True],
       ['Overcast', 'Hot', 'Normal', False],
       ['Sunny', 'Mild', 'High', True],
       ['Rainy', 'Cool', 'Normal', True]], dtype=object)
```

In [6]:

```
# encoding Strings before training
from sklearn.preprocessing import LabelEncoder
le = LabelEncoder()
for i in range(len(train_x[0])):
    train_x[:,i] = le.fit_transform(train_x[:,i])
```

separate train and test data

In [7]:
```
test_x=train_x[-1]
test_x
```
Out[7]:
```
array([1, 0, 1, 1], dtype=object)
```
In [8]:
```
train_x=train_x[:-1]
train_x
```
Out[8]:
```
array([[1, 1, 0, 0],
       [1, 1, 0, 1],
       [0, 1, 0, 0],
       [2, 2, 0, 0],
       [2, 0, 1, 0],
       [2, 0, 1, 1],
       [0, 0, 1, 1],
       [1, 2, 0, 0],
       [1, 0, 1, 0],
       [2, 2, 1, 0],
       [1, 2, 1, 1],
       [0, 2, 0, 1],
       [0, 1, 1, 0],
       [2, 2, 0, 1]], dtype=object)
```
In [9]:
```
train_y=train_y[:-1]
```
In [10]:
```
classifier = GaussianNB()
classifier.fit(train_x, train_y)
```
Out[10]:
```
GaussianNB()
```
In [11]:
```
pred_y=classifier.predict([test_x])
```
```
/home/paleti/.local/lib/python3.8/site-packages/sklearn/utils/validation.py:63: FutureWarning: Arrays of byt
es/strings is being converted to decimal numbers if dtype='numeric'. This behavior is deprecated in 0.24 and
will be removed in 1.1 (renaming of 0.26). Please convert your data to numeric values explicitly instead.
  return f(*args, **kwargs)
```

In [12]:
```
pred_y
```

Out[12]:
```
array(['Yes'], dtype='<U3')
```

Conclusion:

```
The result for the record (Rainy, Cool, Normal, True) is predicted as 'YES' by the naive
bayes classifier trained on the dataset given
```

Test it with a large dataset

In [13]:
```
heart_df=pd.read_csv("heart_2020_cleaned.csv")
heart_df
```

Out[13]:

	HeartDisease	BMI	Smoking	AlcoholDrinking	Stroke	PhysicalHealth	MentalHealth	DiffWalking	Sex	AgeCategory	Race
0	No	16.60	Yes	No	No	3.0	30.0	No	Female	55-59	White
1	No	20.34	No	No	Yes	0.0	0.0	No	Female	80 or older	White
2	No	26.58	Yes	No	No	20.0	30.0	No	Male	65-69	White
3	No	24.21	No	No	No	0.0	0.0	No	Female	75-79	White
4	No	23.71	No	No	No	28.0	0.0	Yes	Female	40-44	White
...	...	...	...	...	...	...	...	...	...	...	...
319790	Yes	27.41	Yes	No	No	7.0	0.0	Yes	Male	60-64	Hispanic
319791	No	29.84	Yes	No	No	0.0	0.0	No	Male	35-39	Hispanic
319792	No	24.24	No	No	No	0.0	0.0	No	Female	45-49	Hispanic
319793	No	32.81	No	No	No	0.0	0.0	No	Female	25-29	Hispanic
319794	No	46.56	No	No	No	0.0	0.0	No	Female	80 or older	Hispanic

319795 rows × 18 columns

In [14]:

```
from sklearn.preprocessing import OrdinalEncoder
ord_enc = OrdinalEncoder()
for col in heart_df.columns:
    #print(col , heart_df[col].dtype)
    if(heart_df[col].dtype == object):
        heart_df[col] = ord_enc.fit_transform( heart_df[[col]])


heart_df
```

Out[14]:

	HeartDisease	BMI	Smoking	AlcoholDrinking	Stroke	PhysicalHealth	MentalHealth	DiffWalking	Sex	AgeCategory	Race	Diab
0	0.0	16.60	1.0	0.0	0.0	3.0	30.0	0.0	0.0	7.0	5.0	
1	0.0	20.34	0.0	0.0	1.0	0.0	0.0	0.0	0.0	12.0	5.0	
2	0.0	26.58	1.0	0.0	0.0	20.0	30.0	0.0	1.0	9.0	5.0	
3	0.0	24.21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.0	5.0	
4	0.0	23.71	0.0	0.0	0.0	28.0	0.0	1.0	0.0	4.0	5.0	
...	...	...	...	...	...	...	...	...	...	...	...	
319790	1.0	27.41	1.0	0.0	0.0	7.0	0.0	1.0	1.0	8.0	3.0	
319791	0.0	29.84	1.0	0.0	0.0	0.0	0.0	0.0	1.0	3.0	3.0	
319792	0.0	24.24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	3.0	
319793	0.0	32.81	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	3.0	
319794	0.0	46.56	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.0	3.0	

319795 rows × 18 columns

In [15]:

```
heart_train_x=heart_df.iloc[:,[x for x in range(17)]].values
heart_train_y=heart_df.iloc[:,-1].values
```

In [16]:

```
heart_train_x
```

Out[16]:

```
array([[ 0.  , 16.6 ,  1.  , ...,  5.  ,  1.  ,  0.  ],
       [ 0.  , 20.34,  0.  , ...,  7.  ,  0.  ,  0.  ],
```

```
       [ 0.  , 26.58,  1.  , ...,  8.  ,  1.  ,  0.  ],
       ...,
       [ 0.  , 24.24,  0.  , ...,  6.  ,  0.  ,  0.  ],
       [ 0.  , 32.81,  0.  , ..., 12.  ,  0.  ,  0.  ],
       [ 0.  , 46.56,  0.  , ...,  8.  ,  0.  ,  0.  ]])
```

Split the dataset into 80% training and 20% testing

In [17]:
```python
from sklearn.model_selection import train_test_split
```

In [18]:
```python
heart_train_x, heart_test_x, heart_train_y, heart_test_y = train_test_split(heart_train_x, heart_train_y, te
```

In [19]:
```python
classifier = GaussianNB()
classifier.fit(heart_train_x, heart_train_y)
```

Out[19]:
```
GaussianNB()
```

In [20]:
```python
pred_y=classifier.predict(heart_test_x)
```

In [21]:
```python
from sklearn.metrics import accuracy_score
accuracy_score(heart_test_y, pred_y)
```

Out[21]:
```
0.8233399521568505
```

Conclusion:

```
Note:The Dataset contains 319795 rows
The accuracy of this model in predicting skin cancer is 82%
```

Question 2:

1. Implement the Nearest Neighbour Classifier on the given Kaggle dataset with k=7. You are free to use built-in packages for implementation.

In [22]:

```
from sklearn.neighbors import KNeighborsClassifier
from sklearn.model_selection import train_test_split
from sklearn import preprocessing
import matplotlib.pyplot as plt
```

In [23]:

```
fruit_df=pd.read_csv("fruit_data_with_colors.txt",  delim_whitespace=True)
fruit_df
```

Out[23]:

	fruit_label	fruit_name	fruit_subtype	mass	width	height	color_score
0	1	apple	granny_smith	192	8.4	7.3	0.55
1	1	apple	granny_smith	180	8.0	6.8	0.59
2	1	apple	granny_smith	176	7.4	7.2	0.60
3	2	mandarin	mandarin	86	6.2	4.7	0.80
4	2	mandarin	mandarin	84	6.0	4.6	0.79
5	2	mandarin	mandarin	80	5.8	4.3	0.77
6	2	mandarin	mandarin	80	5.9	4.3	0.81
7	2	mandarin	mandarin	76	5.8	4.0	0.81
8	1	apple	braeburn	178	7.1	7.8	0.92
9	1	apple	braeburn	172	7.4	7.0	0.89
10	1	apple	braeburn	166	6.9	7.3	0.93
11	1	apple	braeburn	172	7.1	7.6	0.92
12	1	apple	braeburn	154	7.0	7.1	0.88
13	1	apple	golden_delicious	164	7.3	7.7	0.70
14	1	apple	golden_delicious	152	7.6	7.3	0.69
15	1	apple	golden_delicious	156	7.7	7.1	0.69
16	1	apple	golden_delicious	156	7.6	7.5	0.67
17	1	apple	golden_delicious	168	7.5	7.6	0.73
18	1	apple	cripps_pink	162	7.5	7.1	0.83

	fruit_label	fruit_name	fruit_subtype	mass	width	height	color_score
19	1	apple	cripps_pink	162	7.4	7.2	0.85
20	1	apple	cripps_pink	160	7.5	7.5	0.86
21	1	apple	cripps_pink	156	7.4	7.4	0.84
22	1	apple	cripps_pink	140	7.3	7.1	0.87
23	1	apple	cripps_pink	170	7.6	7.9	0.88
24	3	orange	spanish_jumbo	342	9.0	9.4	0.75
25	3	orange	spanish_jumbo	356	9.2	9.2	0.75
26	3	orange	spanish_jumbo	362	9.6	9.2	0.74
27	3	orange	selected_seconds	204	7.5	9.2	0.77
28	3	orange	selected_seconds	140	6.7	7.1	0.72
29	3	orange	selected_seconds	160	7.0	7.4	0.81
30	3	orange	selected_seconds	158	7.1	7.5	0.79
31	3	orange	selected_seconds	210	7.8	8.0	0.82
32	3	orange	selected_seconds	164	7.2	7.0	0.80
33	3	orange	turkey_navel	190	7.5	8.1	0.74
34	3	orange	turkey_navel	142	7.6	7.8	0.75
35	3	orange	turkey_navel	150	7.1	7.9	0.75
36	3	orange	turkey_navel	160	7.1	7.6	0.76
37	3	orange	turkey_navel	154	7.3	7.3	0.79
38	3	orange	turkey_navel	158	7.2	7.8	0.77
39	3	orange	turkey_navel	144	6.8	7.4	0.75
40	3	orange	turkey_navel	154	7.1	7.5	0.78
41	3	orange	turkey_navel	180	7.6	8.2	0.79
42	3	orange	turkey_navel	154	7.2	7.2	0.82
43	4	lemon	spanish_belsan	194	7.2	10.3	0.70
44	4	lemon	spanish_belsan	200	7.3	10.5	0.72

	fruit_label	fruit_name	fruit_subtype	mass	width	height	color_score
45	4	lemon	spanish_belsan	186	7.2	9.2	0.72
46	4	lemon	spanish_belsan	216	7.3	10.2	0.71
47	4	lemon	spanish_belsan	196	7.3	9.7	0.72
48	4	lemon	spanish_belsan	174	7.3	10.1	0.72
49	4	lemon	unknown	132	5.8	8.7	0.73
50	4	lemon	unknown	130	6.0	8.2	0.71
51	4	lemon	unknown	116	6.0	7.5	0.72
52	4	lemon	unknown	118	5.9	8.0	0.72
53	4	lemon	unknown	120	6.0	8.4	0.74
54	4	lemon	unknown	116	6.1	8.5	0.71
55	4	lemon	unknown	116	6.3	7.7	0.72
56	4	lemon	unknown	116	5.9	8.1	0.73

In [24]:

```
train_x=fruit_df.iloc[:,[0,1,2,3,4,5]].values
train_y=fruit_df.iloc[:,-1].values
```

In [25]:

```
from sklearn.preprocessing import LabelEncoder
le = LabelEncoder()

train_x[:,1] = le.fit_transform(train_x[:,1])
train_x[:,2] = le.fit_transform(train_x[:,2])
train_x
```

Out[25]:

```
array([[1, 0, 3, 192, 8.4, 7.3],
       [1, 0, 3, 180, 8.0, 6.8],
       [1, 0, 3, 176, 7.4, 7.2],
       [2, 2, 4, 86, 6.2, 4.7],
       [2, 2, 4, 84, 6.0, 4.6],
       [2, 2, 4, 80, 5.8, 4.3],
       [2, 2, 4, 80, 5.9, 4.3],
       [2, 2, 4, 76, 5.8, 4.0],
       [1, 0, 0, 178, 7.1, 7.8],
       [1, 0, 0, 172, 7.4, 7.0],
```

```
[1, 0, 0, 166, 6.9, 7.3],
[1, 0, 0, 172, 7.1, 7.6],
[1, 0, 0, 154, 7.0, 7.1],
[1, 0, 2, 164, 7.3, 7.7],
[1, 0, 2, 152, 7.6, 7.3],
[1, 0, 2, 156, 7.7, 7.1],
[1, 0, 2, 156, 7.6, 7.5],
[1, 0, 2, 168, 7.5, 7.6],
[1, 0, 1, 162, 7.5, 7.1],
[1, 0, 1, 162, 7.4, 7.2],
[1, 0, 1, 160, 7.5, 7.5],
[1, 0, 1, 156, 7.4, 7.4],
[1, 0, 1, 140, 7.3, 7.1],
[1, 0, 1, 170, 7.6, 7.9],
[3, 3, 7, 342, 9.0, 9.4],
[3, 3, 7, 356, 9.2, 9.2],
[3, 3, 7, 362, 9.6, 9.2],
[3, 3, 5, 204, 7.5, 9.2],
[3, 3, 5, 140, 6.7, 7.1],
[3, 3, 5, 160, 7.0, 7.4],
[3, 3, 5, 158, 7.1, 7.5],
[3, 3, 5, 210, 7.8, 8.0],
[3, 3, 5, 164, 7.2, 7.0],
[3, 3, 8, 190, 7.5, 8.1],
[3, 3, 8, 142, 7.6, 7.8],
[3, 3, 8, 150, 7.1, 7.9],
[3, 3, 8, 160, 7.1, 7.6],
[3, 3, 8, 154, 7.3, 7.3],
[3, 3, 8, 158, 7.2, 7.8],
[3, 3, 8, 144, 6.8, 7.4],
[3, 3, 8, 154, 7.1, 7.5],
[3, 3, 8, 180, 7.6, 8.2],
[3, 3, 8, 154, 7.2, 7.2],
[4, 1, 6, 194, 7.2, 10.3],
[4, 1, 6, 200, 7.3, 10.5],
[4, 1, 6, 186, 7.2, 9.2],
[4, 1, 6, 216, 7.3, 10.2],
[4, 1, 6, 196, 7.3, 9.7],
[4, 1, 6, 174, 7.3, 10.1],
[4, 1, 9, 132, 5.8, 8.7],
[4, 1, 9, 130, 6.0, 8.2],
[4, 1, 9, 116, 6.0, 7.5],
[4, 1, 9, 118, 5.9, 8.0],
[4, 1, 9, 120, 6.0, 8.4],
[4, 1, 9, 116, 6.1, 8.5],
```

```
        [4, 1, 9, 116, 6.3, 7.7],
        [4, 1, 9, 116, 5.9, 8.1],
        [4, 1, 9, 152, 6.5, 8.5],
        [4, 1, 9, 118, 6.1, 8.1]], dtype=object)
```

encoding

In [26]:

```
lab_enc = preprocessing.LabelEncoder()
train_y = lab_enc.fit_transform(train_y)
train_y
```

Out[26]:

```
array([ 0,  1,  2, 15, 14, 12, 16, 16, 25, 24, 26, 25, 23,  5,  4,  4,  3,
        8, 18, 20, 21, 19, 22, 23, 10, 10,  9, 12,  7, 16, 14, 17, 15,  9,
       10, 10, 11, 14, 12, 10, 13, 14, 17,  5,  7,  7,  6,  7,  7,  8,  6,
        7,  7,  9,  6,  7,  8,  7,  5])
```

Split the dataset into training and testing dataset : 80% training 20%testing

In [27]:

```
train_x, test_x, train_y, test_y = train_test_split(train_x, train_y, test_size = 0.2, random_state=42)
```

Train using the dataset

In [28]:

```
knn = KNeighborsClassifier(n_neighbors=7)
knn.fit(train_x, train_y)
```

Out[28]:

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

Test the model using the dataset

In [29]:

```
 print(knn.score(test_x, test_y))
```

```
0.08333333333333333
```

Try for more values of k - elbow graph

In [30]:

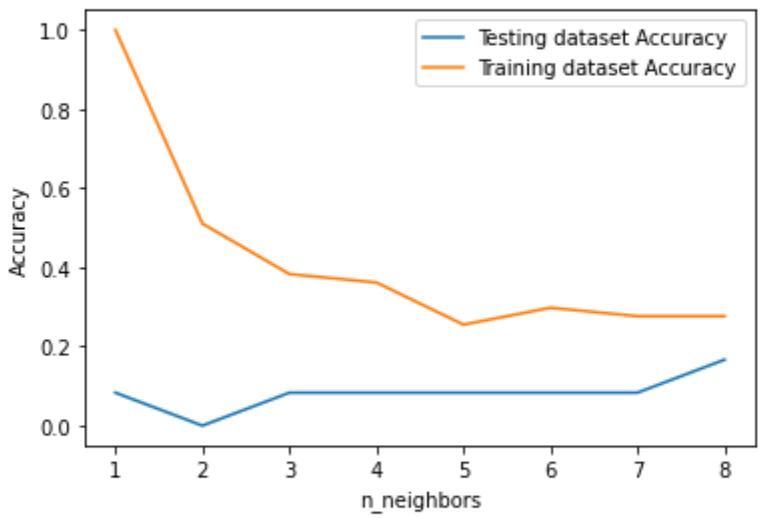
```
neighbors = np.arange(1, 9)
train_accuracy = np.empty(len(neighbors))
test_accuracy = np.empty(len(neighbors))

for i, k in enumerate(neighbors):
    knn = KNeighborsClassifier(n_neighbors=k)
    knn.fit(train_x, train_y)

    train_accuracy[i] = knn.score(train_x, train_y)
    test_accuracy[i] = knn.score(test_x, test_y)


plt.plot(neighbors, test_accuracy, label = 'Testing dataset Accuracy')
plt.plot(neighbors, train_accuracy, label = 'Training dataset Accuracy')

plt.legend()
plt.xlabel('n_neighbors')
plt.ylabel('Accuracy')
plt.show()
```



Question 3: [took basic code from online article]

Develop an application that simulates the working of Genetic Algorithm comprising of Basic Operators such as Selection, Crossover and

Mutation to optimize the objective function max f(x)= x^3-2x^2+x within a range of (0,31). You are free to use any inbuilt / open-source packages supported in the programming platform

In [31]:

```
import random
```

Iteration 1:

Random Intialization of Population:

In [32]:

```
best=100
populations =([[random.randint(0,1) for x in range(5)] for i in range(4)])
print(populations)
```

```
[[1, 0, 0, 1, 1], [1, 1, 0, 0, 1], [1, 1, 0, 0, 1], [0, 1, 1, 1, 0]]
```

Fitness Evaluation:

In [33]:

```
def fitness_evaluation(populations,best,verbose=0) :
    fit_value = []
    fit_score=[]
    for i in range(len(populations)) :
        chromosome_value=0

        for j in range(len(populations[i])-1,-1,-1) :
            chromosome_value += populations[i][j]*(2**(len(populations[i])-1-j))
        fit_value.append((chromosome_value**3)-2*(chromosome_value**2) + (chromosome_value) )

        if(verbose==0):
            print("Population Item = ",populations[i],"\t","Chromosome Value = ",chromosome_value,"\t","Fit
    fit_value, populations = zip(*sorted(zip(fit_value, populations) , reverse = True))
    return populations,fit_value[0]


populations,best=fitness_evaluation(populations,best)
```

```
Population Item =  [1, 0, 0, 1, 1]      Chromosome Value =  19          Fit Value =  6156
Population Item =  [1, 1, 0, 0, 1]      Chromosome Value =  25          Fit Value =  14400
Population Item =  [1, 1, 0, 0, 1]      Chromosome Value =  25          Fit Value =  14400
Population Item =  [0, 1, 1, 1, 0]      Chromosome Value =  14          Fit Value =  2366
```

Selection Process:

In [34]:

```
def selection_process(populations,verbose=0):
    parents=populations[0:2]
    if(verbose==0):
        print(parents)
    return parents
parents=selection_process(populations)
```

```
([1, 1, 0, 0, 1], [1, 1, 0, 0, 1])
```

Crossover Process:

In [35]:

```
def crossover_process(parents,verbose=0) :
    cross_point = random.randint(0,len(parents[0])-1)
    parents=parents + tuple([(parents[0][0:cross_point +1] +parents[1][cross_point+1:len(parents[0])])])
    parents =parents+ tuple([(parents[1][0:cross_point +1] +parents[0][cross_point+1:len(parents[0])])])

    if(verbose==0):
        print(parents)
    return parents
parents=crossover_process(parents)
```

```
([1, 1, 0, 0, 1], [1, 1, 0, 0, 1], [1, 1, 0, 0, 1], [1, 1, 0, 0, 1])
```

Mutation Process:

In [36]:

```
def mutation_process(populations,parents,verbose=0) :
    flip = random.randint(0,100)
    if flip == 50 :
        x=random.randint(0,len(parents)-1)
        y = random.randint(0,len(parents[0])-1)
        parents[x][y] = 1-parents[x][y]
    populations = parents
    if(verbose==0):
        print(populations)
    return populations

populations=mutation_process(populations,parents)
```

```
([1, 1, 0, 0, 1], [1, 1, 0, 0, 1], [1, 1, 0, 0, 1], [1, 1, 0, 0, 1])
```

Evolution Process :

> Repeat the process of Fitness Evaluation -> Selection -> Crossover -> Mutation -> Fitness Evalution to find the best values or repeat until the solution converges to provide the optima for the function

In [37]:

```
verbose=1
for i in range(1000) :
    populations,best=fitness_evaluation(populations,best,verbose)
    parents=selection_process(populations,verbose)
    parents=crossover_process(parents,verbose)
    populations=mutation_process(populations,parents,verbose)
    #print(i,"\n\n")
    if(i%50==0):
        print("Iteration = ",i,"\t","Best = ",best)

print("Final Max Score/Value of the function:")
print(best)
print(" Chromosome Sequence:")
print(populations[0])
```

```
Iteration =  0	 Best =  14400
Iteration =  50	         Best =  14400
Iteration =  100	 Best =  18252
Iteration =  150	 Best =  18252
Iteration =  200	 Best =  18252
Iteration =  250	 Best =  18252
Iteration =  300	 Best =  18252
Iteration =  350	 Best =  18252
Iteration =  400	 Best =  18252
Iteration =  450	 Best =  18252
Iteration =  500	 Best =  18252
Iteration =  550	 Best =  18252
Iteration =  600	 Best =  18252
Iteration =  650	 Best =  18252
Iteration =  700	 Best =  18252
Iteration =  750	 Best =  18252
Iteration =  800	 Best =  18252
Iteration =  850	 Best =  18252
Iteration =  900	 Best =  18252
```

```
Iteration =  950         Best =  18252
Final Max Score/Value of the function:
18252
 Chromosome Sequence:
```

Conclusion:

```
The Above Algorithm first finds the optima value as 8400 among the initial population,after
which the algorithm slowly converges to the max of 27900 (at aroud 500 to 550 iterations
)which occurs for x=31 and the solution as presented is binary digits of 5 1's.

 This no of iterations is subjective as it based on many factors such as initial population
,selection process,chosing crossover point and mutation bits.
```

In [ ]: