CA2

March 2, 2020

[367]:
```
cd
```

```
/Users/fabiannemazi
```

[368]:
```
cd fag_nmbu/Dat200/CA2/Data
```

```
/Users/fabiannemazi/Fag_nmbu/Dat200/CA2/Data
```

0.0.1 Importing the nessescary packages

[372]:
```
import pandas as pd
import seaborn as sns; sns.set(context = 'paper', style = 'whitegrid')
import matplotlib.pyplot as plt
import numpy as np
from perceptron_ext import Perceptron
#from adaline_ext import AdalineGD
```

0.0.2 Creating the column names for the dataframe

[182]:
```
column_names = ['Number_of_times_pregnant', 'Plasma_glucose_concentration',
                'Diastolic_blood_pressure', 'Triceps_skin fold_thickness',␣
 ↪'2-Hour_serum_insulin',
                'Body_mass_index', 'Diabetes_pedigree_function', 'Age',␣
 ↪'Class_variable']
```

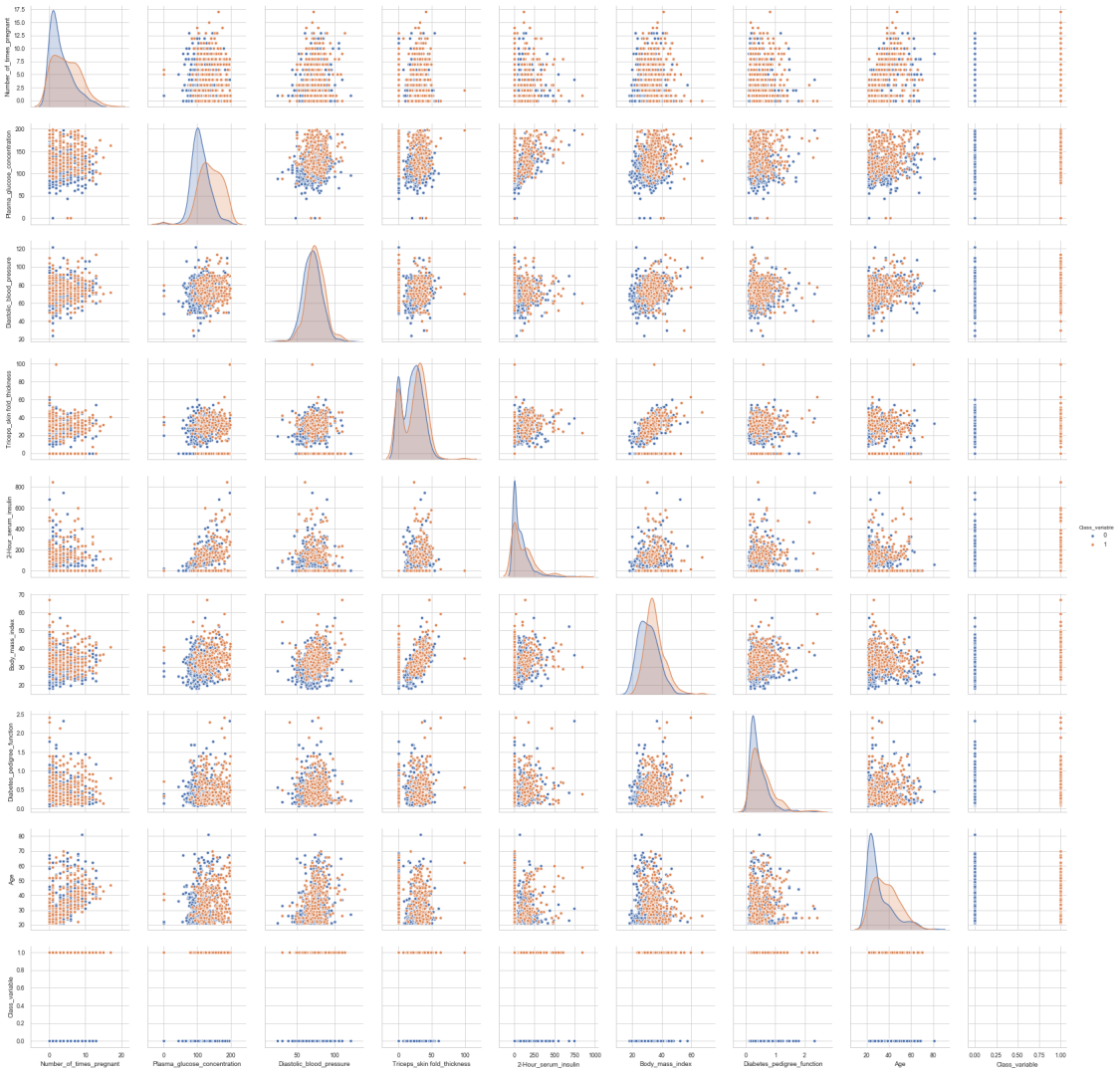
[183]:
```
df = pd.read_csv('CA2_data.csv', names = column_names, header = None)
```

0.0.3 Task 1 : Visualize the raw data

[382]:
```
sns.pairplot(df, hue='Class_variable')
```

```
/opt/anaconda3/lib/python3.7/site-packages/statsmodels/nonparametric/kde.py:487:
RuntimeWarning: invalid value encountered in true_divide
  binned = fast_linbin(X, a, b, gridsize) / (delta * nobs)
/opt/anaconda3/lib/python3.7/site-
packages/statsmodels/nonparametric/kdetools.py:34: RuntimeWarning: invalid value
encountered in double_scalars
  FAC1 = 2*(np.pi*bw/RANGE)**2
```

[382]: <seaborn.axisgrid.PairGrid at 0x1a59f1f990>



At first glance it may look like we don't have to classes that are linearly seperable. For a model like Perceptron, where convergence of to classes are only guaranteeded if they are linearly seperable, this may be hard. It may be a reasonable guess to think that the Adaline model would to better on this dataset.

0.0.4 Task 2: removing all suspsect pasients

[374]:
```
indexing = df.query('Diastolic_blood_pressure == 0 | Body_mass_index == 0').
 ↪index.tolist() #using df.query to pick out the columns i want
df = df.drop(indexing).reset_index(drop = True) # resetting the indexing␣
 ↪because we have removed values
```

0.0.5 Creating functions for splitting and standarizing data

[375]:
```
def scale_features_data(df, X_train, X_test):
    """
    From lecture: standardizes our data-subsets.
    """
    X_train_std = (X_train - np.mean(X_train, axis=0)) / np.std(X_train,␣
↪axis=0, ddof=0)
    X_test_std = (X_test - np.mean(X_train, axis=0)) / np.std(X_train, axis=0,␣
↪ddof=0)

    return X_train_std, X_test_std
```

[376]:
```
def split_dataset(df, num_training_data):
    """
    Splits our dataset into the desired subsets for training and testing.
    """
    X_train = df.iloc[:num_training_data].drop('Class_variable', axis=1).values
    X_test = df.iloc[num_training_data:].drop('Class_variable', axis=1).values

    y_train = df.iloc[:num_training_data, 8].values
    y_test = df.iloc[num_training_data:, 8].values

    y_train = np.where(y_train == 0, -1, 1)
    y_test = np.where(y_test == 0, -1, 1)

    return X_train, X_test, y_train, y_test
```

[377]:
```
#training_set = df.loc[:399, :].values
#test_set = df.loc[400:, :].values
```

[232]:
```
#X_train = training_set[:, :8].values
#y_train = np.where(training_set[:, -1] == 0, -1, 1)
#X_test = test_set[:, :8]
#y_test = np.where(test_set[:, -1] == 0, -1, 1)
```

0.0.6 Creating column names and index names for use later

[149]:
```
Perceptron_columns = ['Epoch ' + str(name)  for name in range(1,51)]
Perceptron_index = [str(index) + ' out of 400' for index in range(50, 450, 50)]
```

0.0.7 Task 3: training the 400 models, computing classification accuracy and storing them in a dataframe

0.0.8 Perceptron algorithm

[378]:
```
df_Perceptron = pd.DataFrame(columns =range(1,51), index=range(50, 450, 50))␣
↪#creating df

for column in list(range(1,51)):
    df_Perceptron[column] = df_Perceptron[column].astype(float)
    #for a weird reason the heatmap plotting woldnt work unless the values was␣
↪float, so that is the reason
    #for me doing this



for nrows in range(50, 450, 50):
    for epoch in range(1,51):
        X_train, X_test, y_train, y_test = split_dataset(df, nrows) #splitting␣
↪the dataset with the func created
        X_train_std, X_test_std = scale_features_data(df, X_train, X_test)␣
↪#Standarizing the datasets
        ppn = Perceptron(eta=0.0001, n_iter=epoch) #Creating Perceptron object ␣
↪
        #train model here
        ppn.fit(X_train_std, y_train)
        # predict
        y_pred = ppn.predict(X_test_std)


        # find accuracy
        accuracy = (y_test == y_pred).sum() / len(y_test) * 100
        df_Perceptron.loc[nrows, epoch] = accuracy


df_Perceptron.columns = Perceptron_columns
df_Perceptron.index = Perceptron_index
```

```
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  0.01744812 -0.00761207  0.00319039]
```

[378]:

	Epoch 1	Epoch 2	Epoch 3	Epoch 4	Epoch 5	\
50 out of 400	41.678940	48.895434	53.166421	55.081001	56.259205	
100 out of 400	47.217806	56.915739	62.480127	64.228935	66.931638	
150 out of 400	54.231434	64.421416	69.775475	73.056995	74.784111	
200 out of 400	59.168242	68.241966	74.669187	75.803403	77.504726	
250 out of 400	62.004175	70.563674	73.486430	73.068894	66.388309	
300 out of 400	65.268065	75.058275	77.389277	74.825175	75.291375	
350 out of 400	68.337731	76.517150	69.656992	70.184697	66.226913	
400 out of 400	70.212766	76.595745	68.996960	73.252280	68.389058	

	Epoch 6	Epoch 7	Epoch 8	Epoch 9	Epoch 10	…	\
50 out of 400	59.204713	60.972018	63.475700	63.917526	65.390280	…	
100 out of 400	68.521463	70.906200	71.224165	72.655008	73.290938	…	
150 out of 400	75.647668	76.165803	75.474957	72.538860	69.948187	…	
200 out of 400	74.858223	75.425331	72.589792	70.321361	70.510397	…	
250 out of 400	54.906054	65.344468	65.762004	62.004175	65.762004	…	
300 out of 400	75.524476	75.291375	75.058275	78.088578	76.456876	…	
350 out of 400	73.614776	72.559367	62.269129	63.588391	66.490765	…	
400 out of 400	68.389058	67.173252	70.516717	70.516717	70.820669	…	

	Epoch 41	Epoch 42	Epoch 43	Epoch 44	Epoch 45	\
50 out of 400	67.157585	64.359352	64.212077	70.397644	67.304860	
100 out of 400	75.198728	71.701113	72.178060	77.106518	73.290938	
150 out of 400	67.702936	65.457686	69.084629	74.438687	72.193437	
200 out of 400	74.102079	72.967864	69.754253	72.211720	73.913043	
250 out of 400	60.542797	60.542797	66.388309	63.674322	66.805846	
300 out of 400	74.592075	78.088578	76.456876	79.020979	78.321678	
350 out of 400	67.810026	68.601583	61.213720	63.588391	73.878628	
400 out of 400	67.173252	75.379939	68.085106	69.300912	70.212766	

	Epoch 46	Epoch 47	Epoch 48	Epoch 49	Epoch 50
50 out of 400	64.948454	66.421208	68.483063	62.886598	69.513991
100 out of 400	71.065183	73.608903	75.834658	73.131955	73.449921
150 out of 400	65.284974	67.012090	66.839378	70.639033	67.702936
200 out of 400	75.803403	73.345936	70.510397	71.644612	74.858223
250 out of 400	68.893528	67.640919	63.048017	62.421712	67.223382
300 out of 400	76.223776	75.990676	75.757576	76.923077	76.223776
350 out of 400	70.184697	65.963061	73.878628	67.810026	69.129288
400 out of 400	63.525836	72.644377	75.683891	69.908815	75.075988

```
[8 rows x 50 columns]
```

0.0.9 Doing the same just with adaline algorithm

[299]:
```
df_Adaline = pd.DataFrame(columns =range(1,51), index= range(50, 450, 50) )
Adaline_columns = ['Epoch ' + str(name)  for name in range(1,51)]
Adaline_index = [str(index) + ' out of 400' for index in range(50, 450, 50)]
```

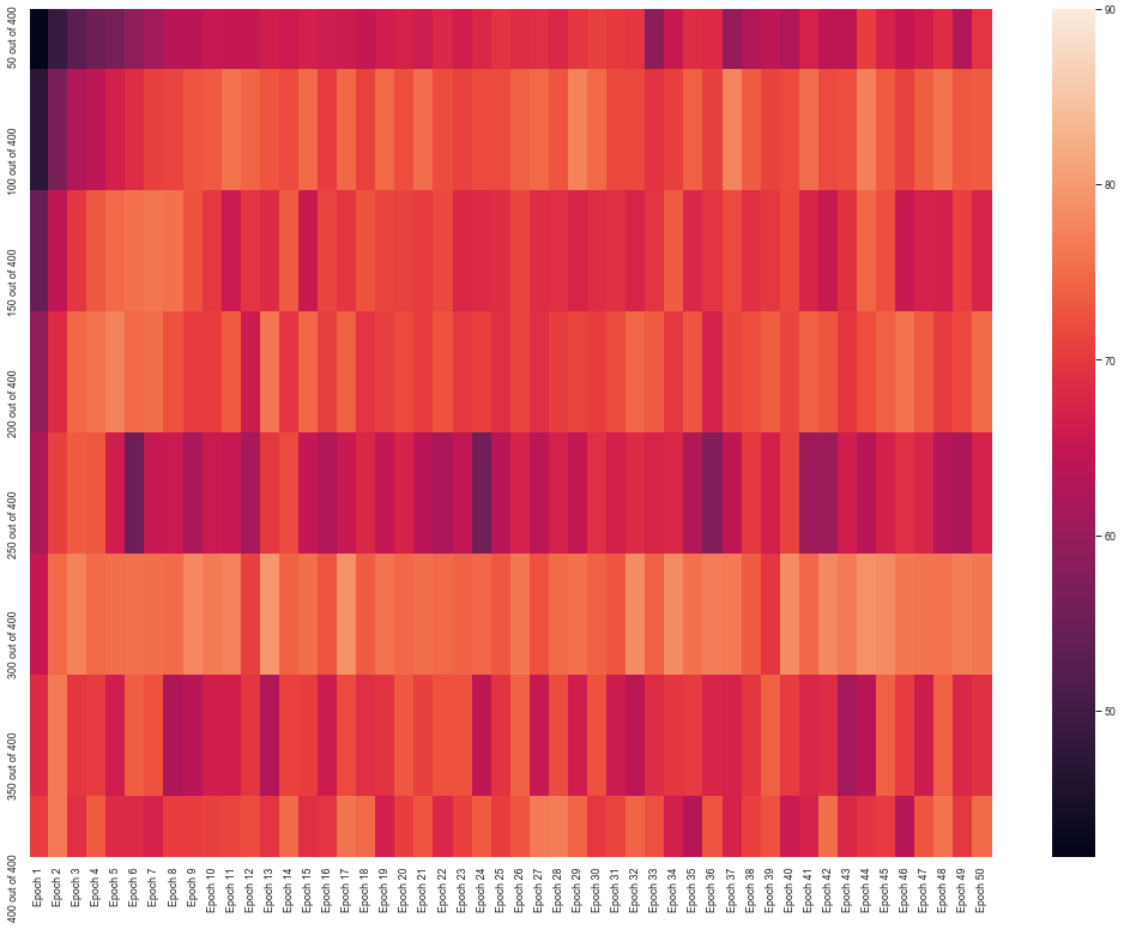
[300]:
```
for column in range(1,51):
    df_Adaline[column] = df_Adaline[column].astype(float)
for nrows in range(50, 450, 50):
    for epoch in range(1,51):
        X_train, X_test, y_train, y_test = split_dataset(df, nrows)
        X_train_std, X_test_std = scale_features_data(df, X_train, X_test)
        ada = AdalineGD(eta=0.0001, n_iter=epoch)
        #train model here
        ada.fit(X_train_std, y_train)
        # predict
        y_pred = ada.predict(X_test_std)


        # find accuracy
        accuracy = (y_test == y_pred).sum() / len(y_test) * 100
        df_Adaline.loc[nrows, epoch] = accuracy

df_Adaline.columns = Adaline_columns
df_Adaline.index = Adaline_index
```

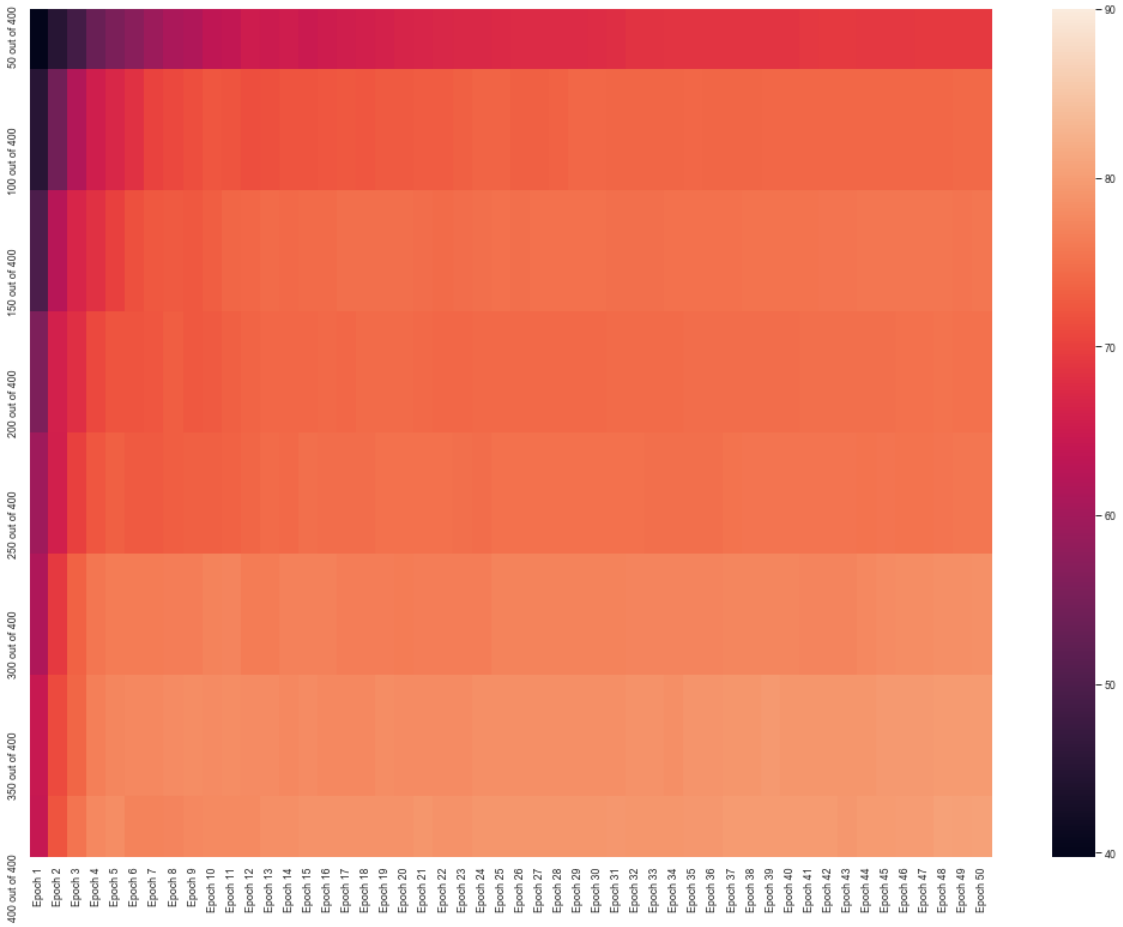
0.0.10 Task 4: Plotting the heatmap of Perceptron

[270]:
```
plt.subplots(figsize=(18,13))
ax = sns.heatmap(df_Perceptron, vmax=90)
```



0.0.11 Plotting the heatmap of Adaline

[304]:
```
plt.subplots(figsize=(18,13))
ax = sns.heatmap(df_Adaline, vmax=90)
```



0.0.12 Task 5: maximum test set classification accuracy

0.0.13 Perceptron maximum

[381]:
```
highest_value_ppn = max(list(df_Perceptron.max())) #storing the highest value␣
 ↪found in the dataset
epoch_iteration_ppn = df_Perceptron.max().idxmax() #storing the epoch that was␣
 ↪assosciated with highest value
index_value_ppn = df_Perceptron[epoch_iteration].idxmax() #Getting the index␣
 ↪for that value as well
print(f'For Perceptron the highest accuracy value was: {highest_value_ppn}␣
 ↪\nThe epoch was: {epoch_iteration_ppn} \nThe size of the dataset was:␣
 ↪{index_value_ppn}')
```

```
For Perceptron the highest accuracy value was: 79.48717948717949
The epoch was: Epoch 13
The size of the dataset was: 300 out of 400
```

0.0.14 Adaline Maximum

[380]:
```
highest_value_ada = max(list(df_Adaline.max())) #storing the highest value␣
↪found in the dataset
epoch_iteration_ada = df_Adaline.max().idxmax() #storing the epoch that was␣
↪assosciated with highest value
index_value_ada = df_Adaline[epoch_iteration].idxmax() #Getting the index for␣
↪that value as well
print(f'For Perceptron the highest accuracy value was: {highest_value_ada}␣
↪\nThe epoch was: {epoch_iteration_ada} \nThe size of the dataset was:␣
↪{index_value_ada}')
```

```
For Perceptron the highest accuracy value was: 80.54711246200608
The epoch was: Epoch 48
The size of the dataset was: 400 out of 400
```

1 TASK 6: training time

The reason for the longer simulation time in Perceptron versus Adaline is that during the Perceptron model training it updates the weight immediately after a misclassification. So during a specific epoch, it can update the weight multiple times. The Adaline only updates at the end of each Epoch. So in a big simulation this will be considerably more time confusing for Perceptron.

[ ]:
```

```