CS 480/680 assignment 1 (coding part)

- Please save a copy of this notebook to avoid losing your changes.
- Debug your code and ensure that it can run before submission.
- Save the output of each cell. Failure to do so may result in your coding questions not being graded.
- Submit your completed version of this notebook.

Question 1-2

In this question, you are asked to implement the perceptron algorithm on the Spambase dataset. Please refer to the dataset webpage for details on the dataset, and consult the lecture slides and suggested readings for details on the perceptron algorithm.

- Please note that `is_spam` is the label of the dataset. The labellings are 0/1 instead of -1/1 (which was used for the perceptron covered in class).
- Recording the accuracy after every step may be costly, therefore you can instead record the accuracy every x steps, where x can be 100, 1000, your training set size, 4601 (the size of the dataset), or any other value you find appropriate.
- It is recommended that you split the dataset into training/validation/testing datasets, but we will not deduct marks if you don't.
- You will get full marks for
  - Correct implementation of the perceptron algorithm
  - An accuracy (on the validation dataset, if you splitted the dataset) vs number of training steps plot that relects the progress of the training
  - Final reported accuracy (on the testing dataset, if you splitted the dataset)

In [ ]:

```
import urllib.request
import pandas as pd
# TODO: add any other package you need

# Download the dataset
url = 'https://archive.ics.uci.edu/ml/machine-learning-databases/spambase/spamb
filename = 'spambase.csv'
urllib.request.urlretrieve(url, filename)

# Load the dataset into a Pandas dataframe
column_names = [
    'word_freq_make', 'word_freq_address', 'word_freq_all', 'word_freq_3d',
    'word_freq_our', 'word_freq_over', 'word_freq_remove', 'word_freq_internet'
    'word_freq_order', 'word_freq_mail', 'word_freq_receive', 'word_freq_will',
    'word_freq_people', 'word_freq_report', 'word_freq_addresses',
    'word_freq_free', 'word_freq_business', 'word_freq_email', 'word_freq_you',
    'word_freq_credit', 'word_freq_your', 'word_freq_font', 'word_freq_000',
    'word_freq_money', 'word_freq_hp', 'word_freq_hpl', 'word_freq_george',
    'word_freq_650', 'word_freq_lab', 'word_freq_labs', 'word_freq_telnet',
    'word_freq_857', 'word_freq_data', 'word_freq_415', 'word_freq_85',
    'word_freq_technology', 'word_freq_1999', 'word_freq_parts',
    'word_freq_pm', 'word_freq_direct', 'word_freq_cs', 'word_freq_meeting',
    'word_freq_original', 'word_freq_project', 'word_freq_re',
    'word_freq_edu', 'word_freq_table', 'word_freq_conference', 'char_freq_;',
    'char_freq_(', 'char_freq_[', 'char_freq_!', 'char_freq_$',
    'char_freq_#', 'capital_run_length_average', 'capital_run_length_longest',
    'capital_run_length_total', 'is_spam'
]
data = pd.read_csv(filename, names=column_names)
```

In [ ]:

```
import numpy as np
```

In [ ]:

```
# random shuffle of data
seed = 10
np.random.seed(seed=seed)

data_shuffled = data.iloc[np.random.permutation(len(data))]
data = data_shuffled.reset_index(drop=True)
```

In [ ]:

```
# perceptron uses +1, -1 instead of 0, 1. So well convert 0 to -1
data.loc[data["is_spam"] == 0, "is_spam"] = -1
```

In [ ]:

```
# split dataset into training, validation, testing
train_split_pct, val_split_pct = 0.8, 0.1
num_train_ex, num_val_ex = int(len(data) * train_split_pct), int(len(data) * va

train_idx = num_train_ex
val_idx = num_train_ex + num_val_ex

train_data, val_data, test_data = data[:train_idx], data[train_idx:val_idx], da
train_data = train_data.reset_index(drop=True)
val_data = val_data.reset_index(drop=True)
test_data = test_data.reset_index(drop=True)
```

In [ ]:

```
def calculate_acc(dataset, w, b):
    correct = 0
    for i in range(len(dataset)):
        x = dataset.loc[i, dataset.columns != "is_spam"].values
        y = dataset.iloc[i]["is_spam"]

        if np.sign(y) == np.sign(np.dot(w, x) + b):
            correct += 1

    return correct / len(dataset)
```

In [ ]:

```
# TODO: your implementation
def perceptron_train(train_dataset, val_dataset, epochs = 1000, report_each=10
    #init params
    w = [0] * (train_dataset.shape[1] - 1) # b/c target is not included
    b = 0
    validation_accs = []
    training_accs = []

    target = "is_spam"

    for epoch in range(epochs):
        print(epoch)
        for index in range(len(train_dataset)):
            # get random index
            #index = np.random.randint(0, len(train_dataset))

            y = train_dataset.iloc[index][target]
            x = train_dataset.loc[index, train_dataset.columns != target].value

            if y * (np.dot(x, w) + b) <= 0:
                w = w + y*x
                b = b + y

            if index % report_each == 0:
                training_accs.append(calculate_acc(train_dataset, w, b))
                validation_accs.append(calculate_acc(val_dataset, w, b))

    return w, b, training_accs, validation_accs
```

In [ ]:

```
epochs = 50
report_each = 1000
w, b, train_accs, val_accs = perceptron_train(train_dataset=train_data, val_dat
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```

In [ ]:

```
import matplotlib.pyplot as plt
```

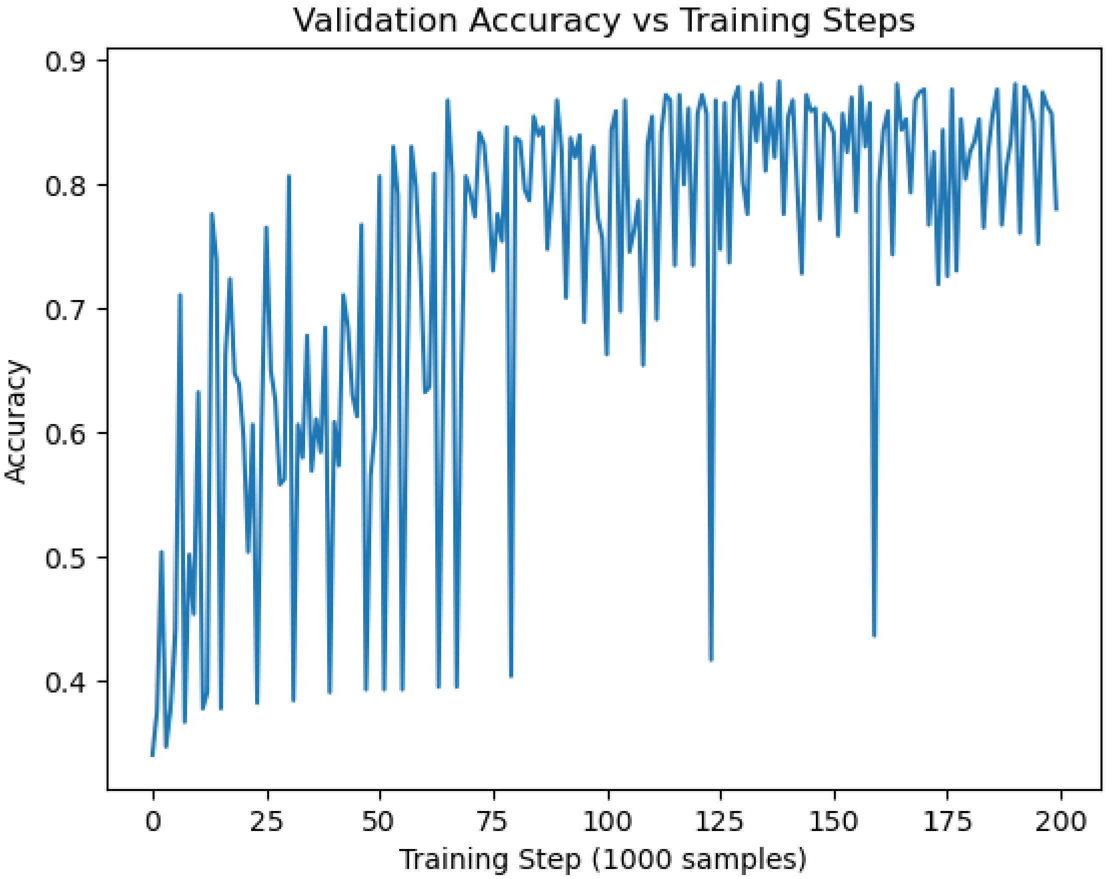
In [ ]:

```
plt.plot([i for i in range(len(val_accs))], val_accs)

plt.title("Validation Accuracy vs Training Steps")
plt.xlabel("Training Step (1000 samples)")
plt.ylabel("Accuracy")
```

Out[ ]:

```
Text(0, 0.5, 'Accuracy')
```



In [ ]:

```python
# TODO: plot the accuracy against the number of steps
# TODO: report the final accuracy
```

In [ ]:

```python
print(f"Test data accuracy: {calculate_acc(test_data, w, b)}")
```

```
Test data accuracy: 0.8806941431670282
```

In [ ]: