CAP 4628/5627 Affective Computing
Project 1
Due 2/25 by 11:59pm

Project Description

The US Armed Forces has over 2 million soldiers when reserve components are included. It includes the Army, Marines, Air Force, and Coast Guard. New ways to manage soldiers' pain, in the fight against opioid abuse, are being investigated.

One way of managing soldier's pain is identifying and treating pain as soon as it occurs. Considering this, they are interested in ways to automatically determine if soldiers are in pain (e.g. wounded), in real-time.

They are unsure if this is possible with current tech. They are hoping that you can help them by developing a new system that can identify (i.e. classify) pain from physiological data that will be collected from wearable devices. You will have access to the type of data that will be collected to train and test your system. For the output, you need to provide the accuracy and confidence of your system.

Experimental Design

- You are required to write a script called Project1.py, however, you are free to split up your program into multiple files.
- Data types available: Diastolic BP, Systolic BP, EDA, and Respiration
- Your script needs to take a command line parameter to determine which data type will be run - python Project1.py <data_type>, where data_type is one of the following:
    - dia – Diastolic BP
    - sys – Systolic BP
    - eda – EDA
    - res – Respiration
    - all – Fusion of all data types
- There are 60 subjects in total, each having the 5 data types above for both classes (pain and no pain). Data has been collected into a CSV file with the following columns: Subject ID, Data Type, Class, Data. Data is variable length, which is a common problem when working with physiological data.
- You will create *hand-crafted features* for this project. From Data you will calculate the mean, variance, entropy, min, and max for all 4 data types. In total there will be 20 features (5 features from each type). These values are your training and testing data.
    - For the 4 data types, you will have a list of size 5 for each instance of the data. For the fusion, you will create a list of size 20 that contains all data types.
- You will use these features to build and train a random forest to classify pain vs. no pain. For this project, you can use the code from HW 2 for a random forest, however, you can use the default values for creating the random forest (RandomForestClassifier()). If you

want to change them, feel free to experiment with what the different parameters do given different values. As you change them, you will see differences in accuracy.

- For training your models and testing, you need to perform 10-fold cross-validation. The same subject cannot be in the training and testing. Each fold will have 6 subjects in it. You will use 9 of them for training and 1 for testing. You need to test on each fold.
- The output of your script must print the confusion matrix, classification accuracy, precision, and recall. As you are doing 10-fold cross validation, you need to take the average of these values over all folds of your testing. For the confusion matrix, you will have 10 confusion matrices from each test, you need to add these matrices and take the average for the final matrix.
- Final note on experiments. Overall accuracy does not matter for this project. You are not required to classify at 100% accuracy. The goal is to learn how different data types can give different accuracies for the same problem.

Questions

1. Which data type had the highest accuracy? Was it a data type that is commonly associated with pain? (You may want to search physiological responses to pain). Describe why it is commonly associated with pain. In your answer include the accuracy, recall, precision, and confusion matrix for the data type with the highest accuracy. If you have more than 1 data type with highest accuracy, you should detail all of them here.
2. Fusing data is a common approach in machine learning. How did your fusion features (e.g. all from command line) perform? If it had the highest accuracy (from question 1) why did this happen (you can search for why fusion works in machine learning)? If it was not the highest accuracy, why do you think this is the case (search why fusion works, then think about physiological responses to pain)?
3. Is there a lot of variability in the features that you created? Why do you think this is? To answer this, create a box plot that contains all the features. In other words, the plot will have 1 box for each feature type which will include lines coming from them that shows the variability of each feature. (Search for box plot in python to see how to do this).
4. Which physiological signal can visually be seen to have the most variability? To answer this, take a random instance of the original physiological signals and plot them on 1 line graph. Include a key to show which signal is which (can use different colors for each). Is the signal that looks like it has the most variability one that is commonly associated with pain. Give details about why you think it is or is not.
5. **(CAP 5627 only)** There is some evidence that some physiological signals are correlated with facial movement (e.g. expressions) during levels of intense emotion (e.g. pain in this case). Give your thoughts and critiques on this. For this question, back up your answer with at least 1 citation from a published paper.

Turn in

- Turn in a zip file of working python script(s). PDF with answers to the Questions above. You can format this as you want, as long as it is neat and easy to read.