**Bio 4990/6990: Computational Activity—Convolutional Neural Networks**

1. Describe the model we are fitting in this activity:
   1. Goal:
   2. Features (X variables):
   3. Response (Y labels):
   4. Algorithm:
2. Describe the model initially fit in this activity. Provide information on the numbers and types of layers, the numbers and sizes of filters in the convolutional layers, the size of filters in the maximum pooling layers, and the numbers of hidden layers and the number of neurons in each hidden layer. Also discuss the loss function used. **How many learnable parameters are in this model?**
3. After fitting the model for the first time, observe the plot of the training and validation accuracy across epochs, and answer the following questions.
   1. Report the training and validation accuracies (**use these as a baseline below**.)
   2. Compare the training and validation accuracies, and discuss whether there is any indication of overfitting or underfitting.
   3. Based on the changes you see in the accuracy across epochs, do you think this model needs to be trained for more epochs? If so, increase the number of epochs to 10 and re-fit the model. Do you think the model has trained long enough now?
4. Return to using five epochs, and change the number of convolutional layers:

* Remove the second convolution and maximum pooling layers (comment it out to make it easier to add back in).
* Add a third set of convolutional + maximum pooling layers (filters and sizes identical to layer 2)
  1. How does changing the number of convolutional layers impact training and validation accuracy, and why do you think this happens?

1. Changing the sizes of the filters in the convolutional layers:

Use the model with two convolutional and maximum pooling layers.

* Increase the filter sizes in both layers to (4,4)
* Decrease the filter sizes in both layers to (2,2)
  1. How does changing the size of the filters impact training and validation accuracy, and why do you think this happens?

1. Changing the dropout rate:

Use the model with two convolutional and maximum pooling layers and (3,3) filters.

* Increase the dropout rate to 0.5
* Decrease the dropout rate to 0.05
  1. How does changing the dropout rate impact training and validation accuracy, and why do you think this happens?

1. Changing the activation functions:

Use the model with two convolutional layers and (3,3) filters and a dropout rate of 0.2.

Try changing the activation function of the hidden layer to **sigmoid** and **LeakyReLU.**

* 1. Which activation function (ReLU, sigmoid, or LeakyReLU) performs best for this task?

1. Select the model you think is the best. You may consider only the models you created to answer the above questions, or explore other changes to the model.
   1. Diagram or describe your model. Include the same information as requested in 2.
   2. Report the training and validation accuracy.
   3. Based on the training and validation accuracy, do you think this model has overfit or underfit the data?
   4. Does the model need more epochs for training?
2. **6990 Only**. Report the confusion matrices for the training and validation datasets.