**Identifying the Severity of Knee Osteoarthritis Utilizing Machine Learning**
**Research Plan**

## A. Question or Problem being addressed

(Rationale included)
Add statistics at start
State question

- Rationale:

Knee osteoarthritis is the gradual, progressive process in the loss of articular cartilage. Specifically to adults of older age, it is an issue throughout the world in many areas. For example, approximately 25% of people 55 years of age or older have had knee pain on most days in a month for the past year, and about half of them have radiographic osteoarthritis in the knee, a group considered to have symptomatic osteoarthritis. Furthermore, approximately 654 million individuals aged 40 years and older were affected by knee osteoarthritis globally in 2020, highlighting the significant burden this condition imposes. The development of an automated system for the analysis and detection of knee osteoarthritis could offer substantial benefits, not only to medical associations, but also to local communities worldwide.

- Research Question:

I have made the decision to experiment with knee osteoarthritis using machine learning with the modification of hyperparameters in a specified CNN algorithm, with the question of: Which hyperparameter measures corresponded with this dataset through 3 unique image recognition algorithms would result in efficiency and high accuracy? Or in other words: Can I train a consistent neural network algorithm that is highly known for great performance in image recognition, resulting in an accurate way of classifying an x-ray of a knee's severity in terms of osteoarthritis?

## B. Goals/Expected Outcomes/Hypotheses

I hypothesize that training and experimenting with convolutional neural network(CNN)) algorithms that are popularly known for image recognition and processing such as MobilenetV2, ResNet50, and VGG 16 will result in an efficient machine learning- based model that can be utilized for identifying the severity of knee osteoarthritis in an image of an x-ray.

This is because these CNN algorithms are known for success in image recognition when corresponded with the best hyperparameters

**C. Description in detail of method or procedures**

- Materials:

  Computer consisting of the following resources:

  - ➢ TensorFlow - Machine learning platform
  - ➢ Google Colab - Python coding platform
  - ➢ Google Suite for documentation and data storage
  - ➢ Mendely.com - Data source
  - ➢ Matplotlib.pyplot - For generating graphs

- Procedure:
  1. Download the data from the following dataset, and upload it on google drive: Knee Osteoarthritis Dataset
  2. Split the data into train, test, and validation. The split should be 80% train, 10% test, and 10% validation. Modify the data into non-Kellgren-Lawrence grading scale format* only if necessary. An elaboration on this is given at the end of the procedure.
  3. As the advent of the model training, experiment with the MobilnetV2 algorithm against the train and validation datasets, constantly modifying the hyperparameters of epochs, base learning rate, and batch size. When each google colab run is completed, record the experimental results on a google spreadsheet. One example of this corresponds to the image below.
  4. Run the code for a wide hyperparameter spectrum of your choosing. It should be in the following range:
     - ➢ Epochs: 10-50
     - ➢ Learning rate: 0.000001 - 0.05
     - ➢ Batch size: 32
     - ➢ You could experiment with a larger variety of hyperparameters as well, for more potential best models. This process will require an extensive duration of time.
  5. With the results, generate a multi-line plot graph utilizing matplotlib. This helps with the further evaluation as well as depiction of the data. Examples are provided in the next set of slides.
  6. Along with your graph, generate various forms of your data, displaying the accuracy. Examples include a confusion matrix, classification report, and precision/recall score. All of this should be executed with the test dataset, and a saved best model in your google drive for valid, viable results.
  7. Switch the algorithm to ResNet50, and repeat steps #3 - 6
  8. Switch the algorithm to VGG 16, and repeat steps #3 - 6

9. Compare and contrast the best models and their corresponding algorithms, then determine the best model among the algorithms.
10. Convert the best algorithm's model (.h5) into an .onnx file.
11. Lastly, deploy this model as a REST API so that anyone in the world with an internet connection can access it. I used AWS lambda and AWS Gateway to achieve this.

*The Kellgren-Lawrence grading scale evaluates osteophytes and joint space narrowing to assign a score between 0 (no ROA) to 4 (severe ROA) (1, 2, 3). In other words, it evaluates a specified skeletal image and provides it with a designated grade, a number ranging from 0 to 4, in order of severity. 0 would signify no sign of osteoarthritis, while 4 would indicate and represent a severe source of osteoarthritis in the x-ray. I originally planned on experimenting with this utilizing machine learning, however the inaccurate results caused me to revert to a generic categorization.

Risks and Safety:

This experiment is conducted entirely through a device, and does not include any experimentation in relation to dangerous activities. Therefore, there would be no risks and safety, or caution notices.

- Data Analysis: Describe the procedures you will use to analyze the data/results that answer research questions or hypotheses

Proceeding towards the data analysis, you can evaluate the results in your own interpretation. However, it is suggested towards the general experimental structure that you should state the hyperparameters with the best performance, as well as their corresponding accuracy. This is crucial towards further data analysis because precise measures are necessary for a successful experiment. I developed my conclusion by partially approving my hypothesis gradually throughout the data analysis, however the conclusion could be presented in another way as well.

**D. Bibliography: List at least five (5) major references (e.g. science journal articles, books, internet sites) from your literature review.**

Dillon, Charles F., et al. "Prevalence of knee osteoarthritis in the United States: arthritis data from the Third National Health and Nutrition Examination Survey 1991-94." *The Journal of rheumatology* 33.11 (2006): 2271-2279.

Cui, Aiyong, et al. "Global, regional prevalence, incidence and risk factors of knee osteoarthritis in population-based studies." *EClinicalMedicine* 29 (2020).

Stoddart, Jennifer C., et al. "The compartmental distribution of knee osteoarthritis–a systematic review and meta-analysis." *Osteoarthritis and Cartilage* 29.4 (2021): 445-455.

Dong, Ke, et al. "MobileNetV2 model for image classification." *2020 2nd International Conference on Information Technology and Computer Application (ITCA)*. IEEE, 2020.

Tian, Youhui. "Artificial intelligence image recognition method based on convolutional neural network algorithm." *IEEE Access* 8 (2020): 125731-125744.

Theckedath, Dhananjay, and R. R. Sedamkar. "Detecting affect states using VGG16, ResNet50 and SE-ResNet50 networks." *SN Computer Science* 1 (2020): 1-7.

“Knee Osteoarthritis Dataset with Severity Grading.” *Kaggle*, https://www.kaggle.com/datasets/shashwatwork/knee-osteoarthritis-dataset-with-severity/data. Accessed 21 January 2024.