

Knight Foundation School of Computing and Information Sciences

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Computer Aided Diagnosis of Chest X-Ray Images

Student: Jose Illidge

Mentor: **Dr. Ananda M. Mondal**, Assistant Professor

Instructor/Faculty: **Masoud Sadjadi**, Florida International University

PROBLEM

With the ever-growing population around the world and opportunities for global events that can spike the population's need for medical intervention such as what we faced with COVID-19, medical systems around the world are constantly under high tension. In addition, a high volume of patients is tightly coupled with a high volume of data; of which has an underlying limitation for the length of time and the number of iterations that it can be analyzed by a medical professional. Therefore, implementing Machine Learning software to supplement medical professionals can be a valuable intra-dependent component. CAD of Chest X-Ray Images utilizes Deep Learning to process the images for identifying a diagnosis -Normal, COVID-19, Viral Pneumonia, or Lung Opacity. Our involvement was to assist in the analysis and improvement of DenseNet121 implementation, construct a new Convolutional Neural Network to distinguish between images that are chest x-rays and those that are not, and to further the UI/UX of the website.



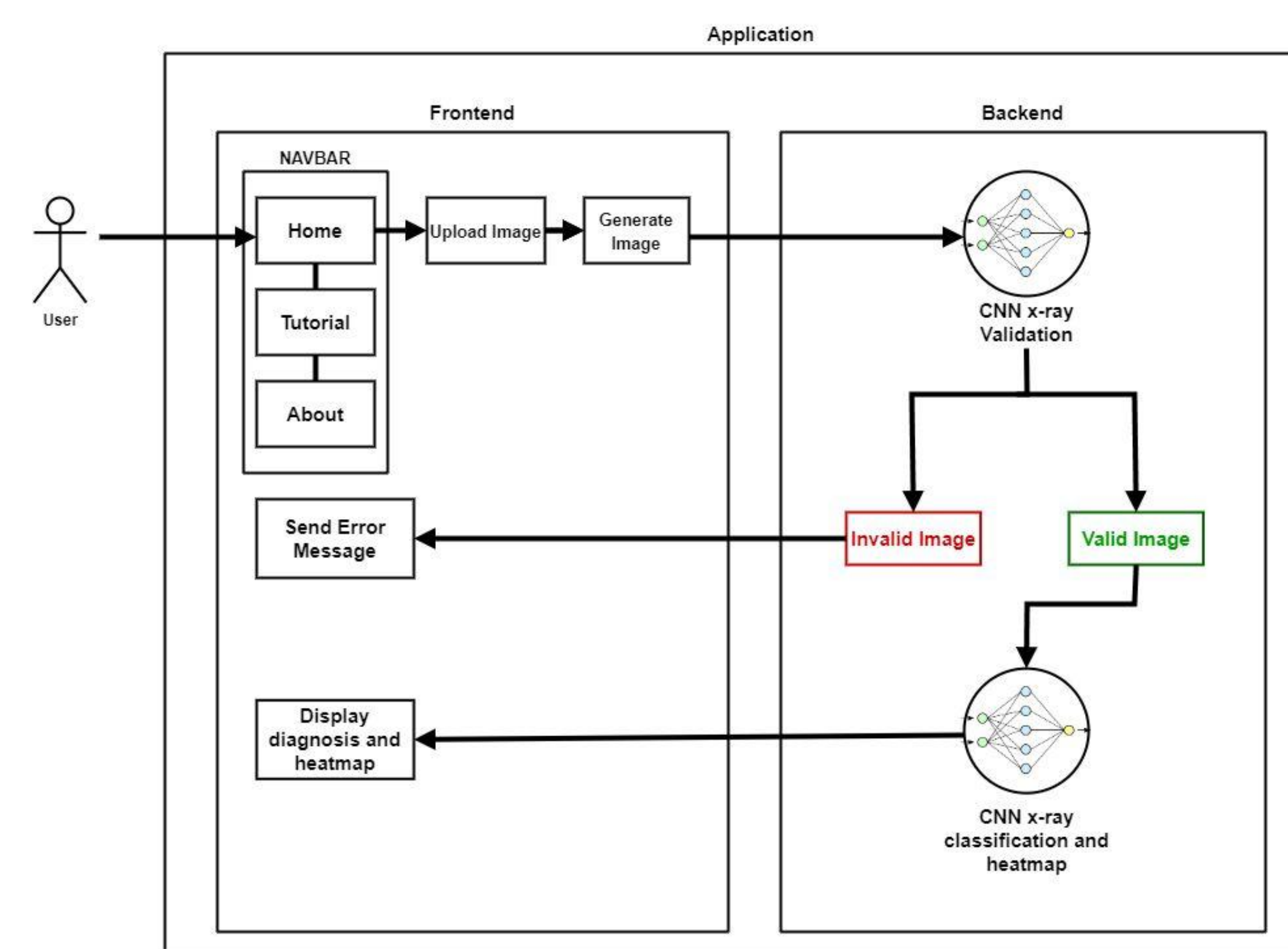
REQUIREMENTS

- JPEG (JPG), and PNG images are acceptable input.
- DenseNet-121 identifies classification of valid image
- ClassActivation model provides heat mapping of valid image
- X-RayValidation model distinguishes between valid and invalid model
- Interactive python computing platform for development (Jupyter Notebooks, Google Colab)

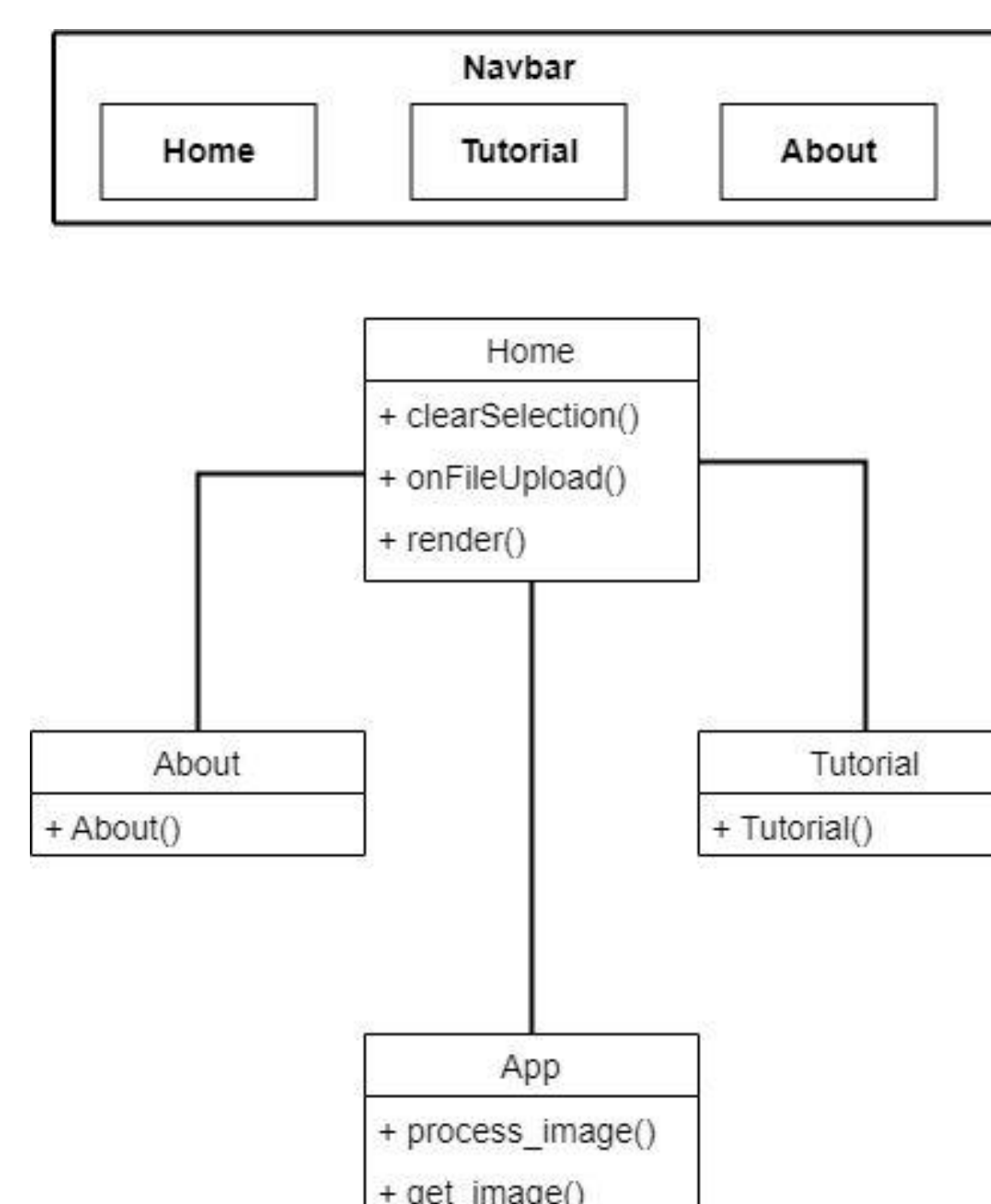
CURRENT SYSTEM

Computer Aided Diagnosis of Chest X-Rays has an established frontend for the user to learn about what the software can do and for the user to input a chest x-ray image into the system. The image is processed through the backend which consists of 2 Convolutional Neural Networks (DenseNet-121, X-Ray Validation) and a Neural Network (Class Activation). First, X-Ray Validation CNN model will distinguish whether it is a valid chest x-ray image and enabling the DenseNet-121 CNN model to predict the diagnosis of the image. Next, the Class Activation NN model constructs a heat activation map on the image which is the final output to the user along with the diagnosis string.

SYSTEM DESIGN



OBJECT DESIGN



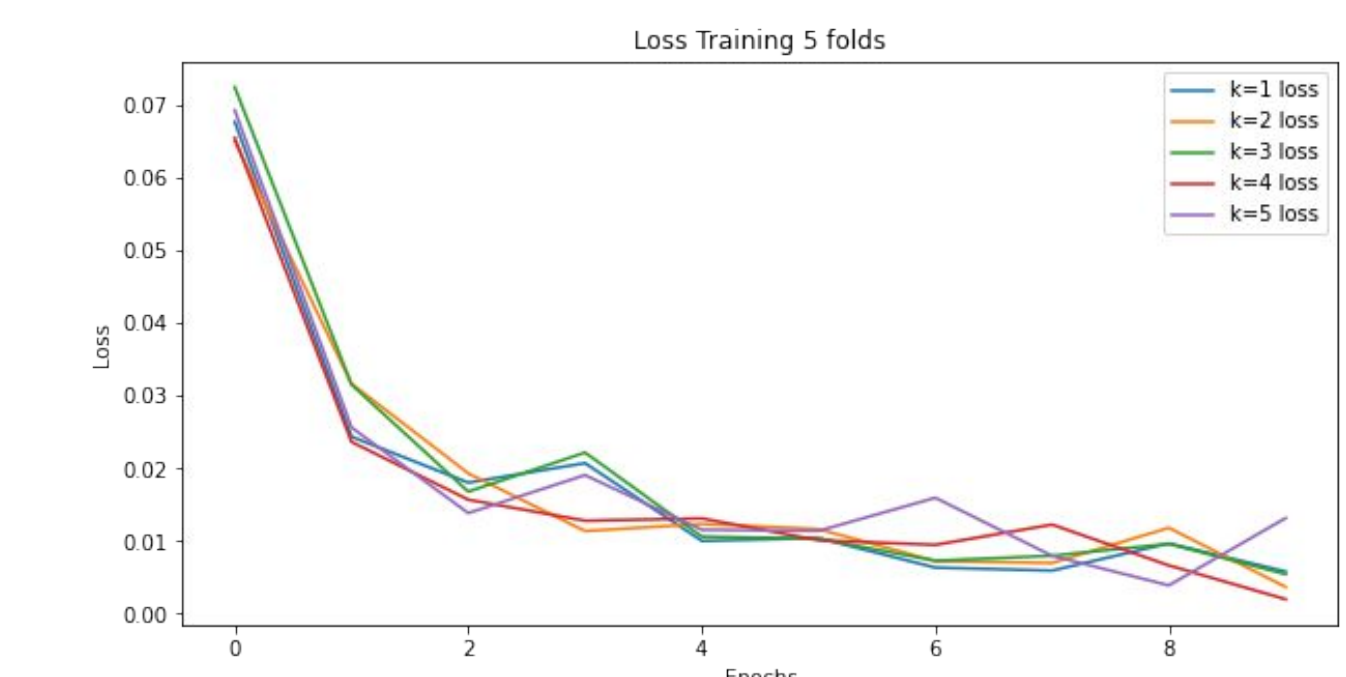
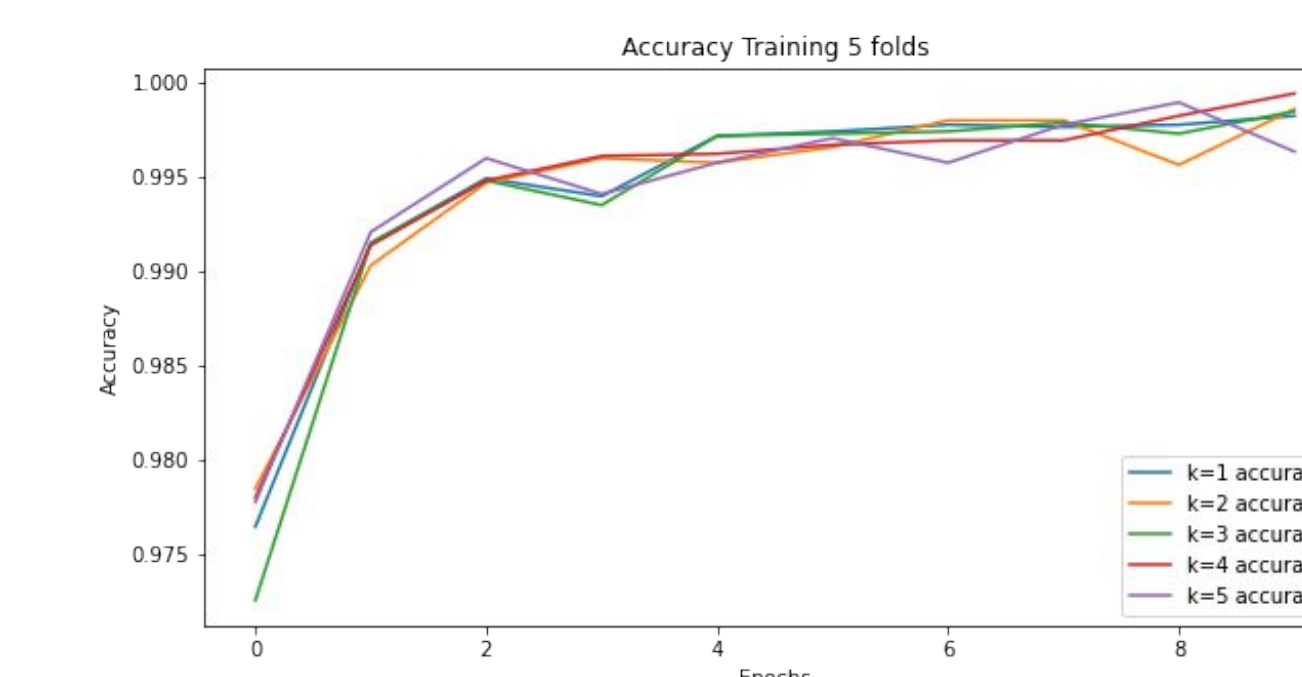
IMPLEMENTATION

My contribution in assisting with developing an x-ray validation CNN model involved -identifying and gathering data, building an input pipeline, building a model, training, and testing the model, and attempting to improve performance. The dataset consisted of x-ray images gathered from the National Institute of Health chest x-ray dataset and non-x-ray images gathered from an imagenet dataset on Kaggle. Next, using TensorFlow, Keras and other modules, the model was trained. After, visualization of the training results was produced using matplotlib to understand any improvements that can be made or inconsistencies such as overfitting. Finally, testing the model yielded some irregularities which I worked to understand and improve. However, CNNs and Machine Learning overall is a vast subject with many intricate details which requires time to develop more expertise. Luckily, my teammate Manuel has had prior experience in this subject and was able to develop his own x-ray validation model that performed very well and the team incorporated it into the project.

SUMMARY

Our involvement in this project lead to adding another key feature to the system that will make a difference in the medical system one day. Although, X-Ray Validation CNN model performs with high accuracy and more importantly DenseNet-121 CNN model performs with very high accuracy, the system is not intended to replace the medical professional, for ethical reasons. However, Machine Learning systems such as this one will greatly strengthen the efficacy of the medical professional. It can provide robustness from the equivalence of having more than one medical professional analyzing the several chest x-ray images produced from a scan. Additionally, it can provide efficiency in analyzing intricate details of a chest x-ray image by aiding in identifying the smallest details in a short length of time.

Finally, to bring a comprehensive system into the medical field there are many more features to incorporate. For instance, HIPPA compliance is critical for any healthcare facility hence, security features can be a necessary step for this software to have. Such as, data encryption for the transfer of images and authentication to upload and receive images/results.



REFERENCES

- Xiaosong Wang, Yifan Peng, Le Lu, Zhiyong Lu, Mohammadhadi Bagheri, Ronald Summers, ChestX-ray8: Hospital-scale Chest X-ray Database and Benchmarks on Weakly-Supervised Classification and Localization of Common Thorax Diseases, IEEE CVPR, pp. 3462-3471, 2017
- Summers, R. (2017, September 1). *NIH Chest X-Ray Dataset*. CXR8. Retrieved February 13, 2023, from <https://nihcc.app.box.com/v/ChestXray-NIHCC>
- Kinakh, V. (2022, September 8). *Stable ImageNet-1K*. Kaggle. Retrieved February 13, 2023, from <https://www.kaggle.com/datasets/vitaliykinakh/stable-imagenet1k>
- Li, F.-F. (n.d.). *Lecture collection | Convolutional Neural Networks for Visual Recognition (spring 2017)*. CS231n: Deep Learning for Computer Vision. Retrieved January 28, 2023, from <http://cs231n.stanford.edu/>

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