Classification of Buildings Post Hurricane

TEAM OUTLIERS:

Nanda Krishna

Prayash Panda

Rajat Gaur

Shishir Tripathi

Introduction

Problem Statement and Dataset:

- The Hurricane Dataset contains the satellite images of houses in a specific region post hurricane. This project aims to determine whether a certain building in the image is damaged or not. It contains images of following classes:
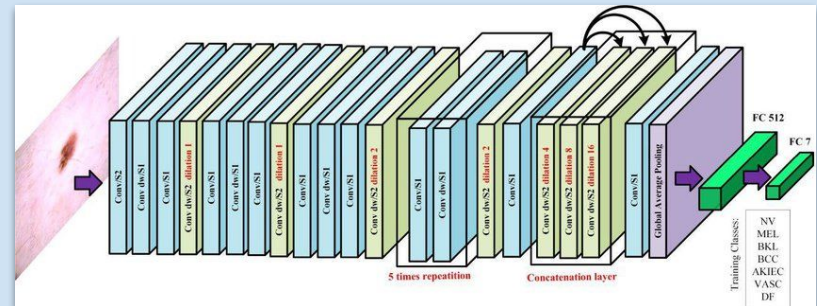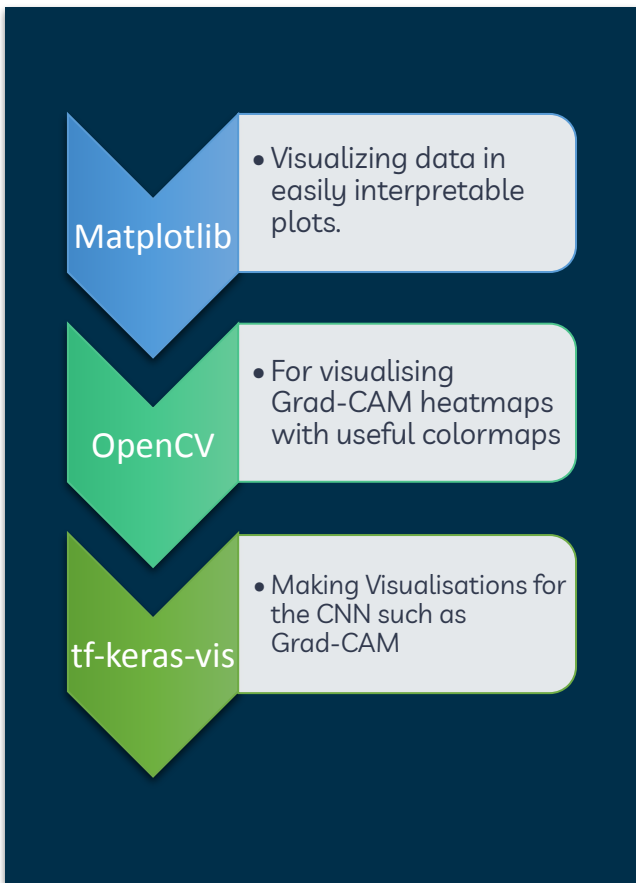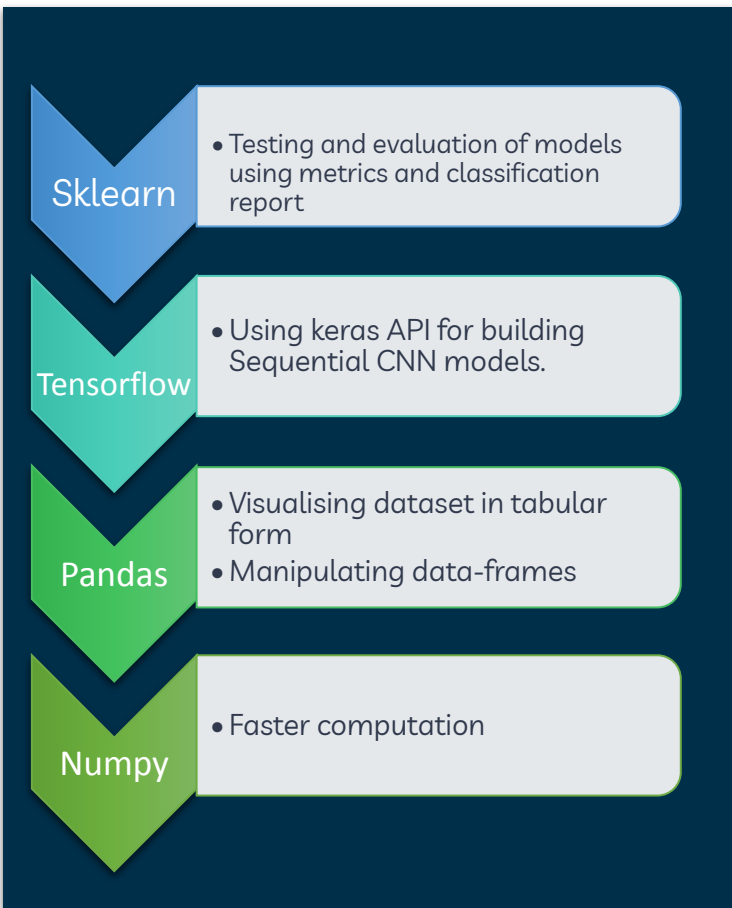
  - **No Damage**
  - **Damage**

Approaches :

- In this project we created two models; one was our own curated CNN model and another being the pre-trained Transfer Learning model based on MobileNetV2.
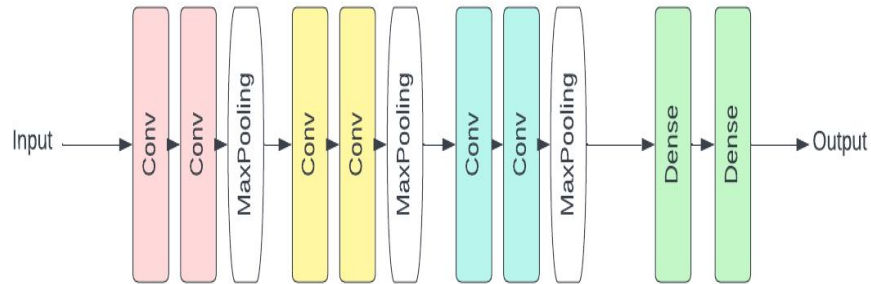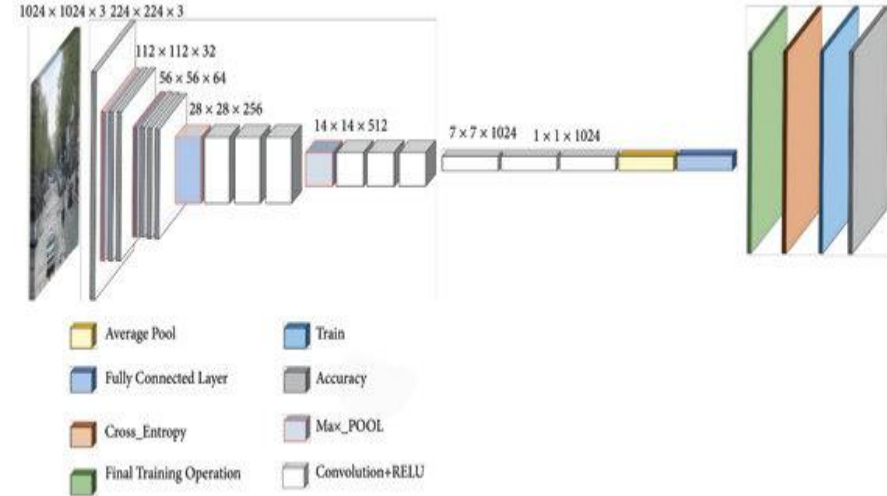
Code & Packages Used:

- **Sklearn**
  - Testing and evaluation of models using metrics and classification report

- **Tensorflow**
  - Using keras API for building Sequential CNN models.

- **Pandas**
  - Visualising dataset in tabular form
  - Manipulating data-frames

- **Numpy**
  - Faster computation

- **Matplotlib**
  - Visualizing data in easily interpretable plots.

- **OpenCV**
  - For visualising Grad-CAM heatmaps with useful colormaps

- **tf-keras-vis**
  - Making Visualisations for the CNN such as Grad-CAM
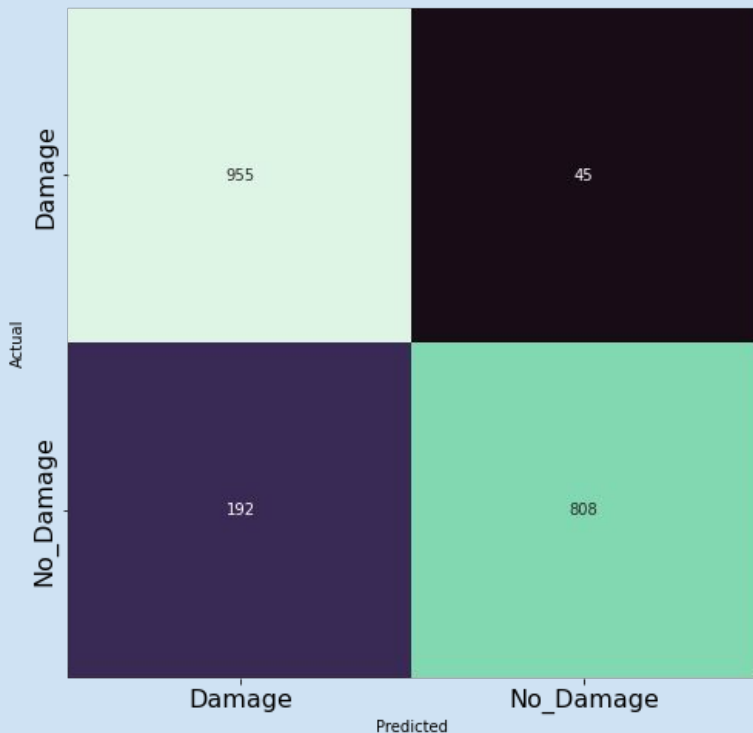
Methodology

Customized CNN :

Pre-trained MobileNetV2 :

Customized CNN Model Results

Confusion Matrix for Balanced Test set

Classification Report for Balanced Test Set:

	precision	recall	f1-score	support
0.0	0.83	0.95	0.89	1000
1.0	0.95	0.81	0.87	1000
accuracy			0.88	2000
macro avg	0.89	0.88	0.88	2000
weighted avg	0.89	0.88	0.88	2000

Classification Report for Imbalanced Test Set:

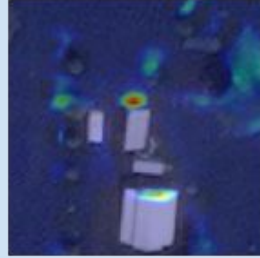|	precision	recall	f1-score	support
0.0	0.98	0.96	0.97	8000
1.0	0.74	0.81	0.77	1000
accuracy			0.95	9000
macro avg	0.86	0.89	0.87	9000
weighted avg	0.95	0.95	0.95	9000

Visualisation for Customised CNN Model

Grad-CAM

Actual : damage
Predicted : damage

GradCam

Actual : no_damage
Predicted : no_damage

GradCam

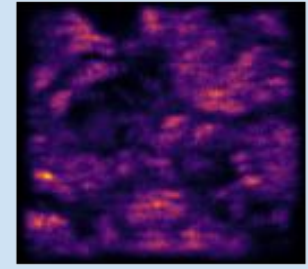## Saliency Maps

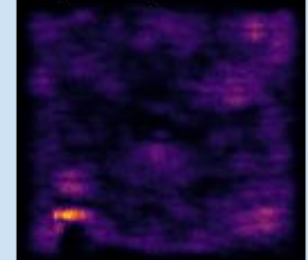Image1

Saliency map for Image 1

Image2

Saliency map for Image 2

Pre-Trained MobileNetV2 Model

Confusion Matrix for Imbalanced Test set

	Damage (Predicted)	No_Damage (Predicted)
Damage (Actual)	7605	395
No_Damage (Actual)	132	868

Classification Report for Balanced Test Set:

	precision	recall	f1-score	support
0.0	0.90	0.96	0.93	1000
1.0	0.96	0.90	0.93	1000
accuracy			0.93	2000
macro avg	0.93	0.93	0.93	2000
weighted avg	0.93	0.93	0.93	2000

Classification Report for Imbalanced Test Set:

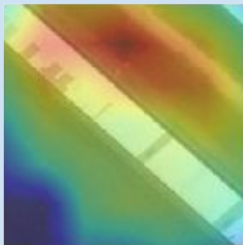|	precision	recall	f1-score	support
0.0	0.98	0.95	0.97	8000
1.0	0.69	0.87	0.77	1000
accuracy			0.94	9000
macro avg	0.84	0.91	0.87	9000
weighted avg	0.95	0.94	0.94	9000

Visualisation for Pre-trained model

GradCAM

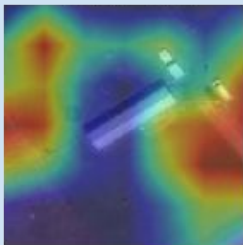Actual : no_damage
Predicted : no_damage
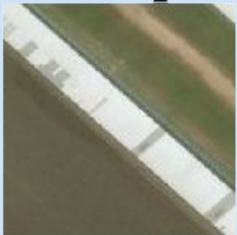
GradCam
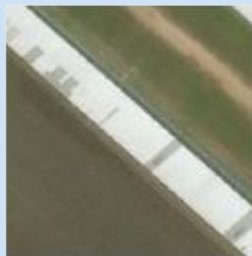
Actual : no_damage
Predicted : no_damage

GradCam

Saliency Maps
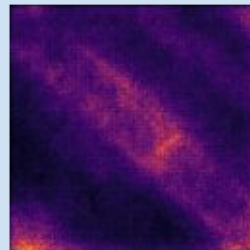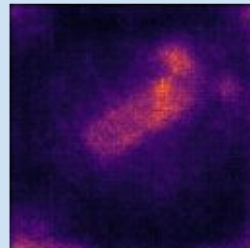
Image0

Saliency map for Image 0

Image1

Saliency map for Image 1

Conclusion

- Our findings suggest us that using the transfer learning approach, the SoTA model - MobilenetV2 has outperformed the customised CNN model for the classification of buildings in terms of accuracy, recall and overall f1-scores.

- The visualizations done with the help of saliency maps have suggested that the SoTA model could capture more important features in the classification task.

- With regards to the task in hand, the MobileNetV2 based model does a significantly better job of classifying damaged houses on both test datasets. Most importantly, it shows great recall score for the imbalanced class (Not Damaged), which prioritises the correct detection of such houses in-order to avoid unnecessary allocation of supplies in real world.

Future Scope of Work

- From this project we can even make an improvement for getting to know the total loss for a specific area and if we have a dataset which consists of even lateral view of the houses then there can be much more accurate predictions.

- Also, if we can extend the study by including the coordinates as well which can be extracted through some other location based dataset which can give us even more accurate predictions.

- We can also develop a web API platform which will take in images from a user and classify it automatically - this part can be included as model deployment with the help of platforms such as Heroku and Flask.

References

- **Dataset description and background research:**

  https://en.wikipedia.org/wiki/Hurricane_Iota

- **Keras functions and handling:**
  https://www.tensorflow.org/api_docs/python/tf/keras

- **For the visualisation of the Class attribution map, we have taken reference from** https://github.com/jacobgil/keras-cam/blob/master/cam.py

- **MobileV2 Net Transfer Learning Approach:**
  https://colab.research.google.com/drive/1eyBBEbMSHn16DTrlkpmunztSRW64UKih?usp=sharing **(University Course Project on Pneumonia Images Classification using chest x-rays)**