Land Use Classification

By :
Akhilesh Gajjar(24MCD001)
Atharv B Trivedi(24MCD002)

Project Definition

- Generally, Land use classification is a process that involves categorizing sections of land based on their primary usage, such as residential, commercial, agricultural, forested, or aquatic areas.

- It is done so as to gain invaluable insights into land distribution and use patterns by urban planners, environmental scientists, and policymakers.

- The aim of this project is to accurately identify the usage type of land(agriculture, buildings, runway, etc.) by trying out various types of CNN models.

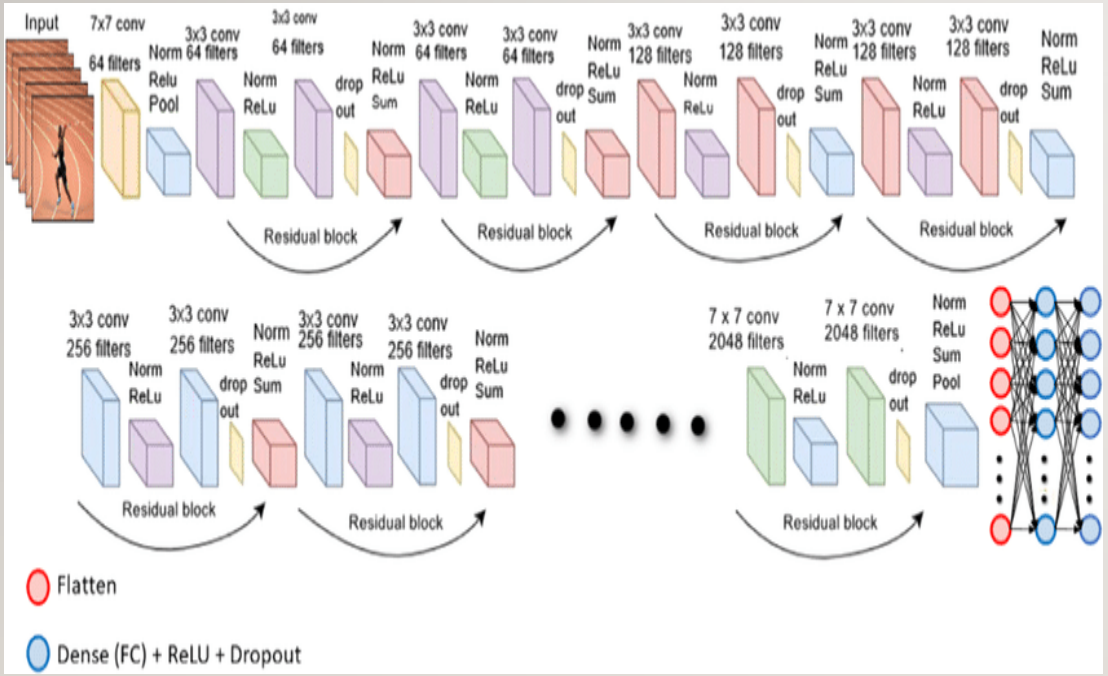
Dataset Description

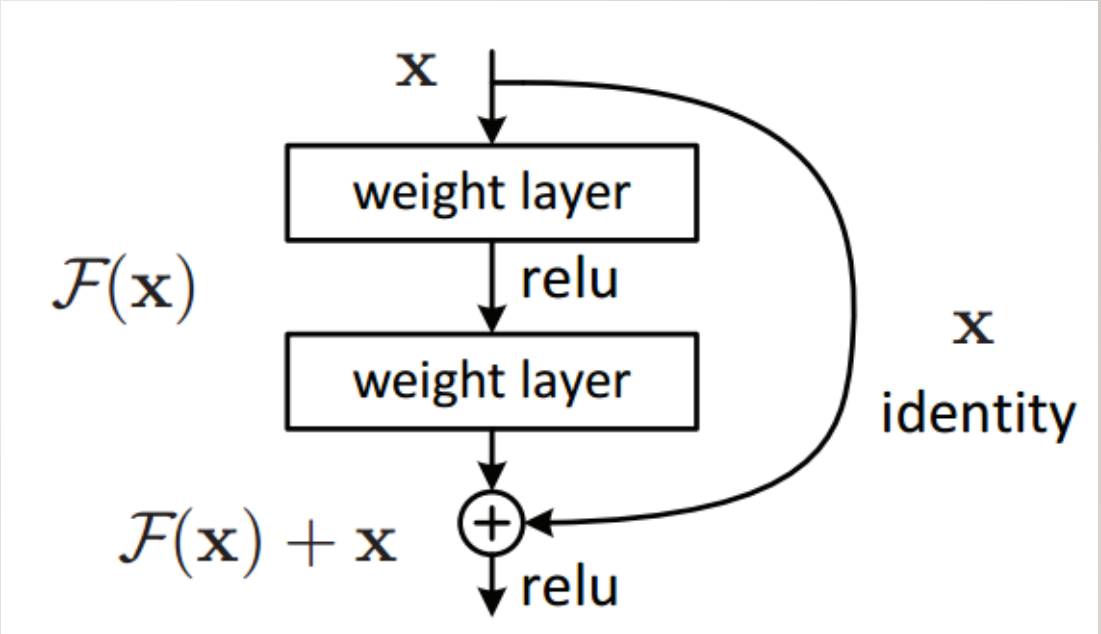
- The UC Merced Land Use Dataset, developed by the University of California, Merced, is a publicly available benchmark dataset designed for land use classification tasks in remote sensing and computer vision.
- It contains high-resolution aerial images with a spatial resolution of 0.3 meters per pixel, covering a variety of land use categories typical of urban, rural, and agricultural settings.
- The images were manually selected from the US Geological Survey (USGS) National Map, making them representative of diverse land covers and land use types across different geographical locations.
- The dataset consists of 21 distinct land use categories, with each category represented by originally 100 images of size 256x256 pixels in RGB color format.
- It has been augmented, wherein each image transformed to make four additional and unique versions of that image for each class. This allows for making a more robust model.
- There are 10,500 images, which has been split for training, testing and validation purpose. For training, each class has 350 images, 50 for testing and 100 for validation.

Approach and Implementation

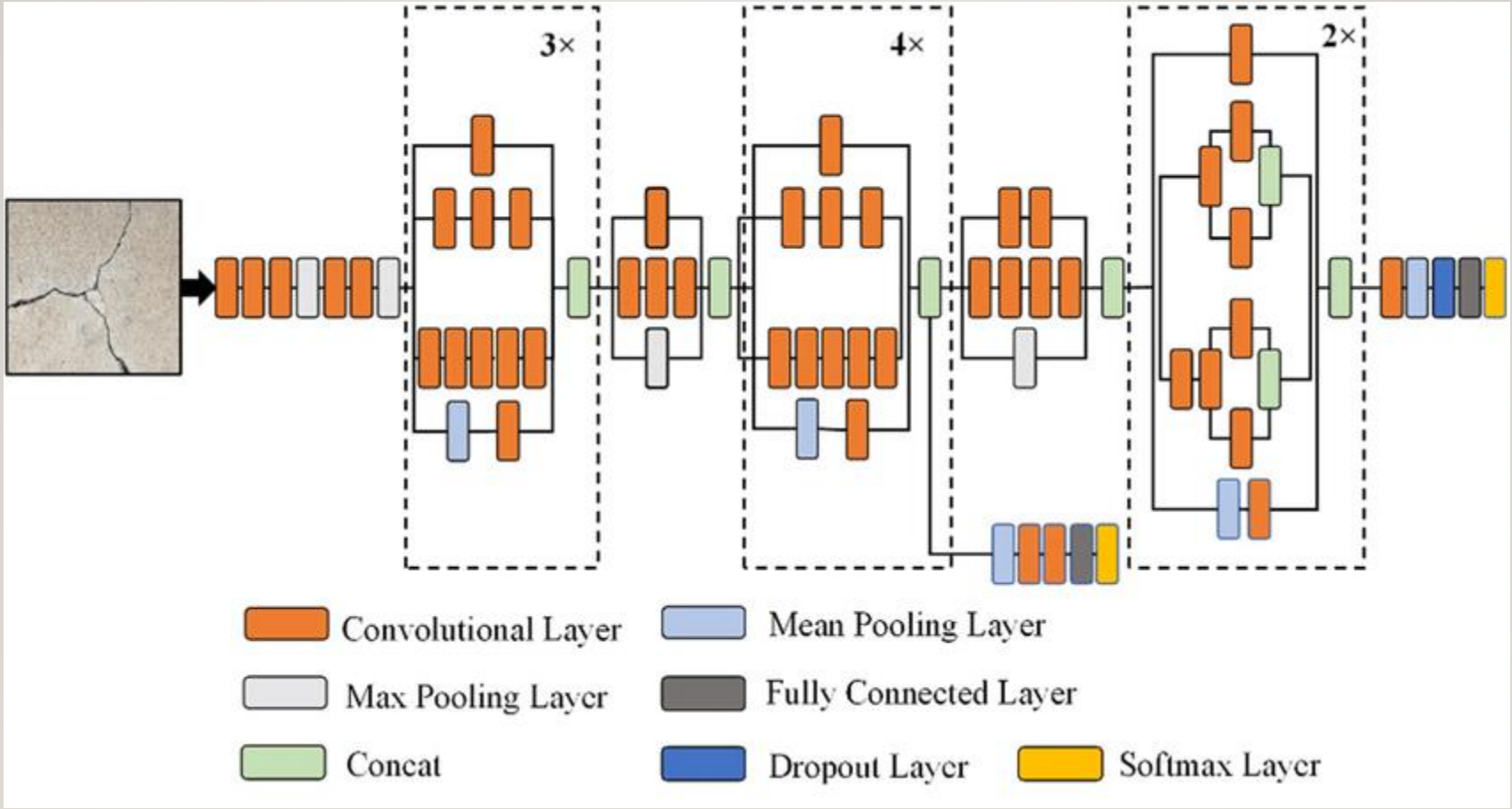
- Imported all the required libraries and data.
- Used ImageDataGenerator to create batches of data.
- Created CNN a model. If using a pre-trained one, remove the topmost layer and add custom layers(GlobalAveragePooling2D, and 2 Dense layers) so as to fit according to the required classification task.
- Compile the model and train it
- Check for loss, accuracy , validation accuracy and validation loss, and do further improvement if required.
- Save the model.

Resnet101V2

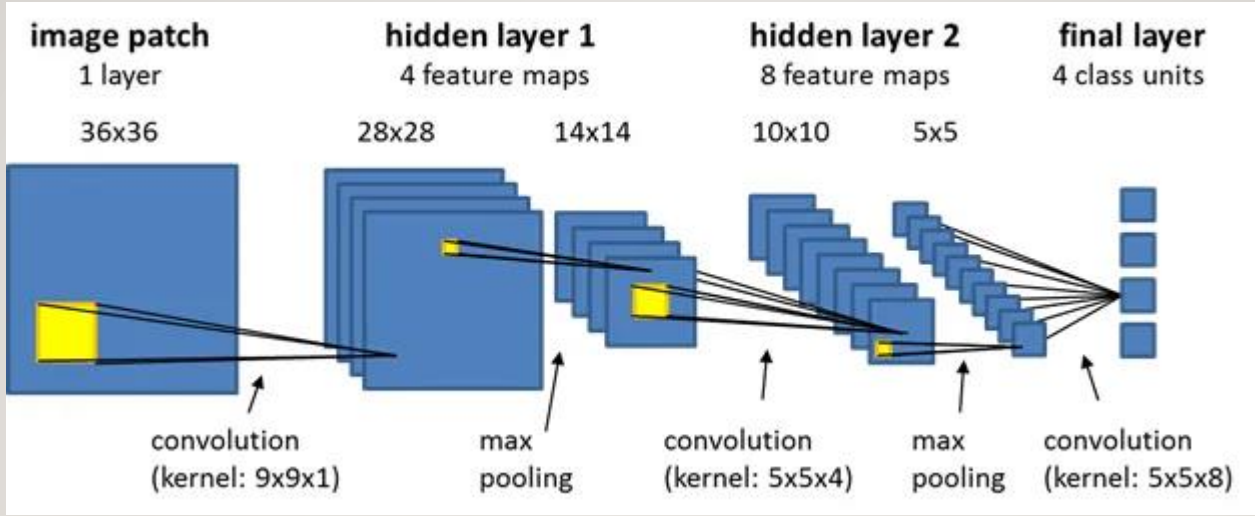




InceptionV3



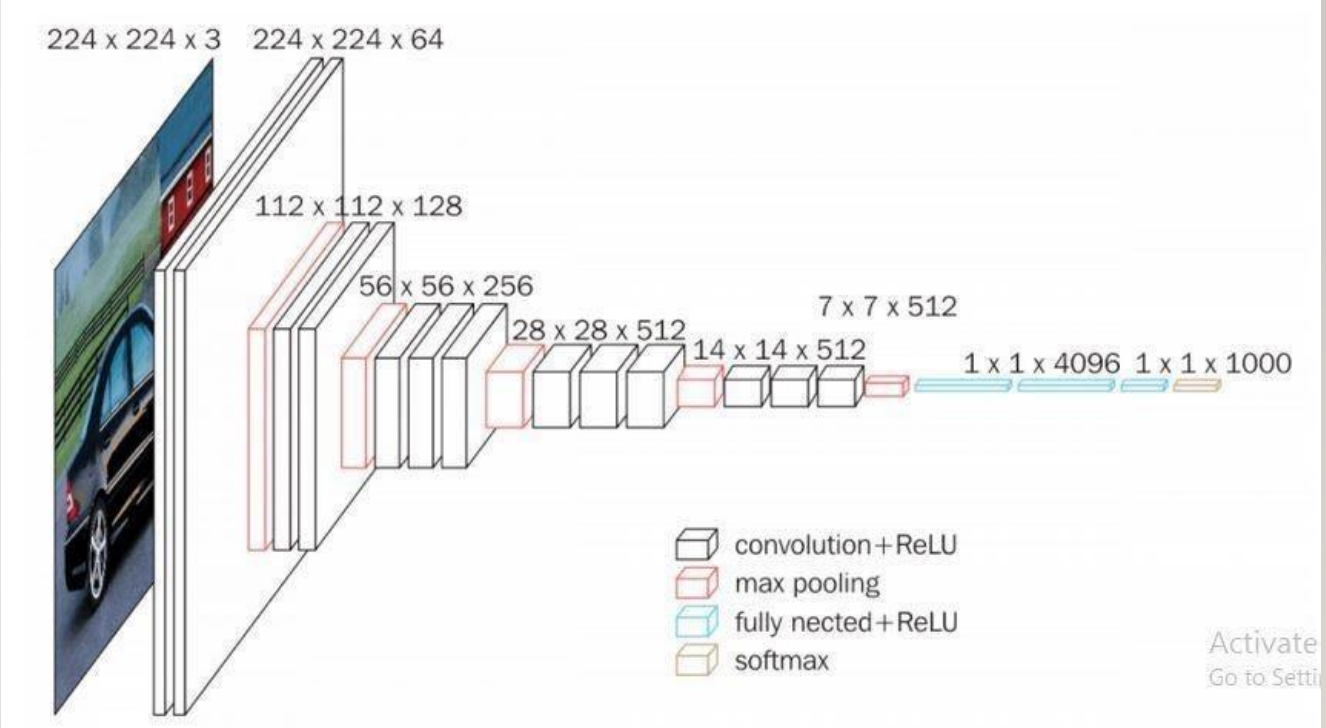
CNN ARCHITECTURE



- Sequential model with 5 Conv2D layers, each followed by MaxPooling and BatchNormalization.
- Final layers include two Dense layers with L2 regularization and Dropout for reducing overfitting.
- Output layer: Softmax for multi-class classification.

VGGNET (VGG16) ARCHITECTURE

- **Base Model**: Pre-trained VGG16 on ImageNet
  - **Weights**: Loaded with ImageNet weights
  - **Top Layers**: Excluded to add custom layers
  - **Frozen Layers**: Base model layers set to non-trainable to retain learned features
- **Custom Layers**:
  - **Flatten Layer**: Converts feature map to a 1D array
  - **Dense Layer**: 1024 neurons with ReLU activation for learning complex patterns
  - **Dropout Layer**: 50% dropout to prevent overfitting
  - **Output Layer**: 21 neurons with Softmax activation for multi-class classification
- **Final Model**: Combines frozen VGG16 with custom layers tailored to our 21-class dataset



RESULTS

Model	Training Accuracy	Validation accuracy	Testing accuracy
Resnet101V2	0.9505	0.9492	0.938
InceptionV3	0.7059	0.9616	0.9695
CNN	0.7688	0.8229	0.81
VGG16	0.9033	0.9616	0.8505

Conclusion

- **Best Model**: InceptionV3 shows the highest testing accuracy, which makes it the top choice for deployment.
- **Generalization:** Resnet101V2 has strong Training / Validation but slightly lower testing accuracy, which is a sign of Overfitting.
- **Balanced Performance**: VGG16 performs will across all metrics, which makes it a reliable alternative.
- **Efficiency**: CNN Model shows lower accuracy which means it is too simple for this task.
- **Recommendations**: Deploy InceptionV3 for the best results, Consider Resnet101V2 with adjustments for overfitting and Explore VGG16 as a balanced and robust option.
- **Future Scope**: Using Data Augmentation and Ensemble Methods, it is possible to further improve performance.