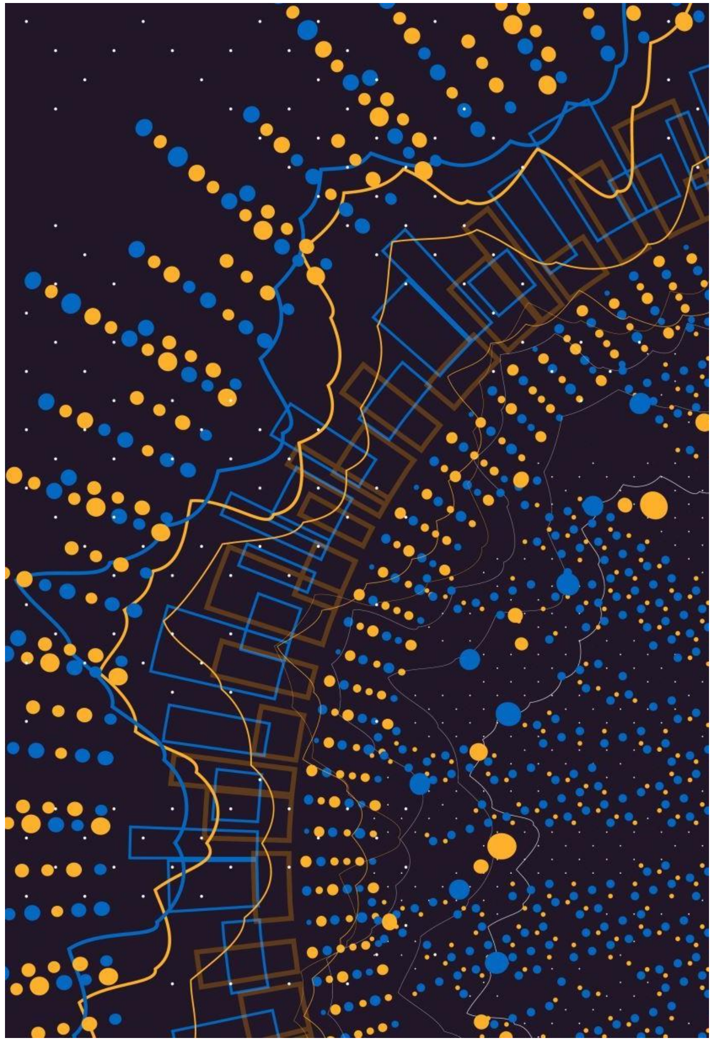

AUTISM SPECTRUM DISORDER DETECTION USING DEEP LEARNING

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Introduction

- Autism Spectrum Disorder (ASD) is a multifaceted neurodevelopmental condition characterized by persistent difficulties in social interaction, communication, and restricted or repetitive behaviors.
- The main objective of the project is to develop a Machine Learning model which can accurately detect the ASD of a person.

Intro

In this project we are the facial images dataset which has been collected from Kaggle.

We choose facial photos because, given the advancements in neural networks, using the structural information found in these images would seem to be a practical way to achieve a rapid and inexpensive test rather than relying on difficult and costly physical measurement procedures.

Literature Review

1. **Study 1**: "A Deep Convolutional Neural Network based Detection System for Autism Spectrum Disorder in Facial Images"
   This study employed a range of machine learning methods including DNN Classifier, LSTM Network, Random Forest Classifier, SVM Classification, and ANN Classifier for ASD detection through image recognition. With an accuracy of 85.3% and an F-Static Score of 20.85, the research demonstrated promising results in identifying ASD from facial images.

2. **Study 2:** "Autism Spectrum Disorder Detection in Children Using Transfer Learning Techniques"

   Utilizing deep learning models such as Efficient Net B7, VGG-16, VGG-19, EfficientNet-B3, and Efficient Net B5, this study investigated ASD detection through image recognition. Results revealed accuracies ranging from 46.50% to 87.50%, showcasing the potential of transfer learning techniques in identifying ASD in children.

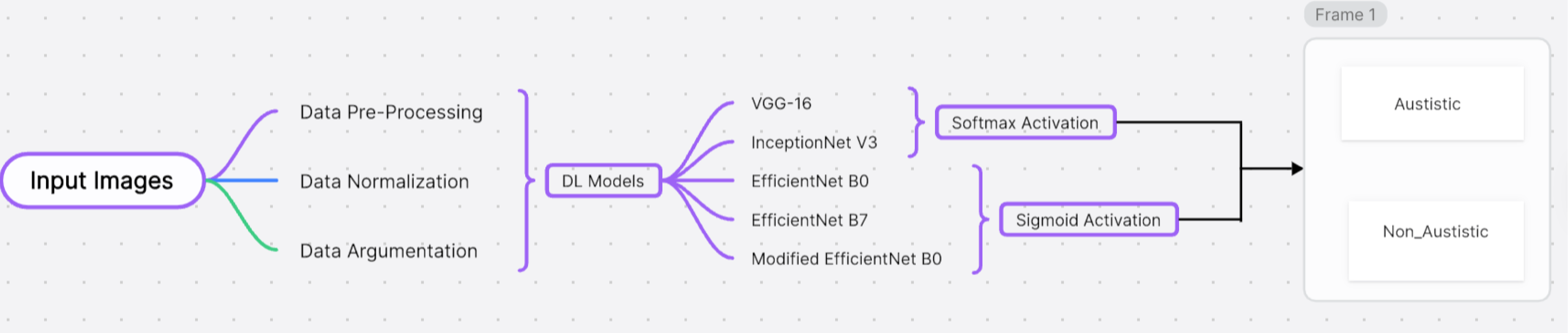
3. **Study 3:** "Autistic Spectrum Disorder Screening: Prediction with Machine Learning Models"

   Focusing on machine learning models like Decision Tree, Random Forest, Logistic Regression, and Support Vector Machine, this study achieved accuracies ranging from 80% to 92% in predicting ASD. By leveraging diverse machine learning algorithms, the research highlighted the efficacy of screening ASD using machine learning techniques.

Dataset

- Three segments have been created from the dataset: train, validation, and test. The test folder has two subfolders named "autistic" and "non-autistic," which hold the images required to test the model once it has been trained.
- A total of 150 JPG photos, each measuring 256x256x3, are present in each subfolder. Similar to the test folder, the train folder is organised into subfolders, each of which holds 1263 photos.
- The valid folder is organized in the same way as the test folder and contains photos used in the model's training to gauge its validation performance.

Project Workflow



Data Pre-Processing

- Data Pre-Processing refers to the cleaning, transforming, and integrating of data in order to make it ready for analysis.
- The goal of data preprocessing is to improve the quality of the data and to make it more suitable for the specific data training task.
- The dataset consists of 2536 images for training, 100 images for validation, and 300 images for testing, distributed across two classes: "autistic" and "non_autistic."
- The best pixel fits for each deep learning (DL) model and the dimensions used for image input are as follows: -
- VGG-16: Input size - 224x224 pixels
- Inception Net: Input size - 224x224 pixels
- Efficient Net B0: Input size - 224x224 pixels
- Efficient Net B7: Input size - 224x224 pixels

Data Normalization

- Data normalization is the process of rescaling input data to have zero mean and unit variance, which improves model stability and convergence during training in deep learning.
- These are different Normalization Techniques used for the ASD Detection:

Normalization Techniques Used	Description
Min-Max Scaling	Scale pixel values to range [0,1]
Z-Score Standardization	Scale pixel values to have zero mean and unit variance
Mean Subtraction	Subtract the mean pixel value from each pixel
Unit Variance Scaling	Scale pixel values to have input variance.

Data Argumentation

- Data augmentation is the process of artificially generating new data from existing data, primarily to train new machine learning (ML) models.
  Data Count before Argumentation = 2536
  Data Count after Argumentation = 2536
  Total Data Count = 5072
- These are the different Argumentation Techniques used for the Project:

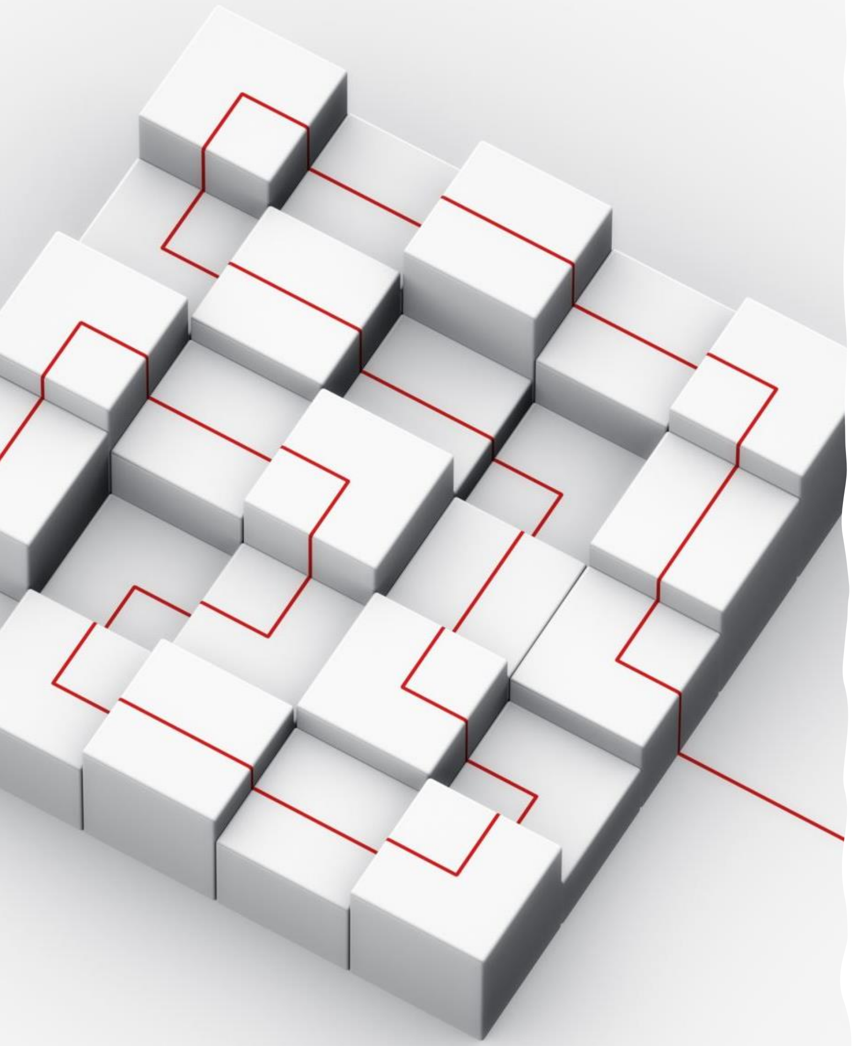
Data Argumentation Technique	**Description**
Rotation	**Rotate the image by a random angle.**
Horizontal Flip	Flip the image horizontally with a certain probability.
Vertical Flip	Flip the image vertically with a certain probability.
Width Shift	Shift the image horizontally by a fraction of its width.
Height Shift	Shift the image vertically by a fraction of its height.
Shear	Apply shear transformation to the image.
Zoom	Zoom into the image by a random factor.
Brightness	Adjust the brightness of the image.
Contrast	Adjust the contrast of the image.

Convolution Neural Networks (CNN)

Convolutional Neural Networks (CNNs) are a class of deep learning models inspired by the structure and function of the human visual cortex.

They are particularly well-suited for tasks involving image recognition, classification, and computer vision tasks due to their ability to learn hierarchical representations of visual data.

At the core of CNNs are neurons, which are basic computational units that receive input signals, apply a transformation (usually a weighted sum), and produce an output signal. These neurons are organized into layers, forming a network that processes input data through multiple stages of feature extraction and abstraction



CNN

- The basic building blocks of CNNs are layers, each serving a specific purpose in the network architecture. The most common types of layers include:
- 1. Convolutional Layers: These layers apply convolution operations to input images, using learnable filters or kernels to extract features such as edges, textures, and patterns.
- 2. Pooling Layers: Pooling layers down sample the feature maps produced by convolutional layers, reducing their spatial dimensions while retaining important features.
- 3. Fully Connected Layers: Fully connected layers, also known as dense layers, connect every neuron in one layer to every neuron in the next layer. These layers perform high-level reasoning and decision-making based on the extracted features from earlier layers

VGG-16

VGG-16 is a convolutional neural network (CNN) architecture proposed by the Visual Geometry Group at the University of Oxford.

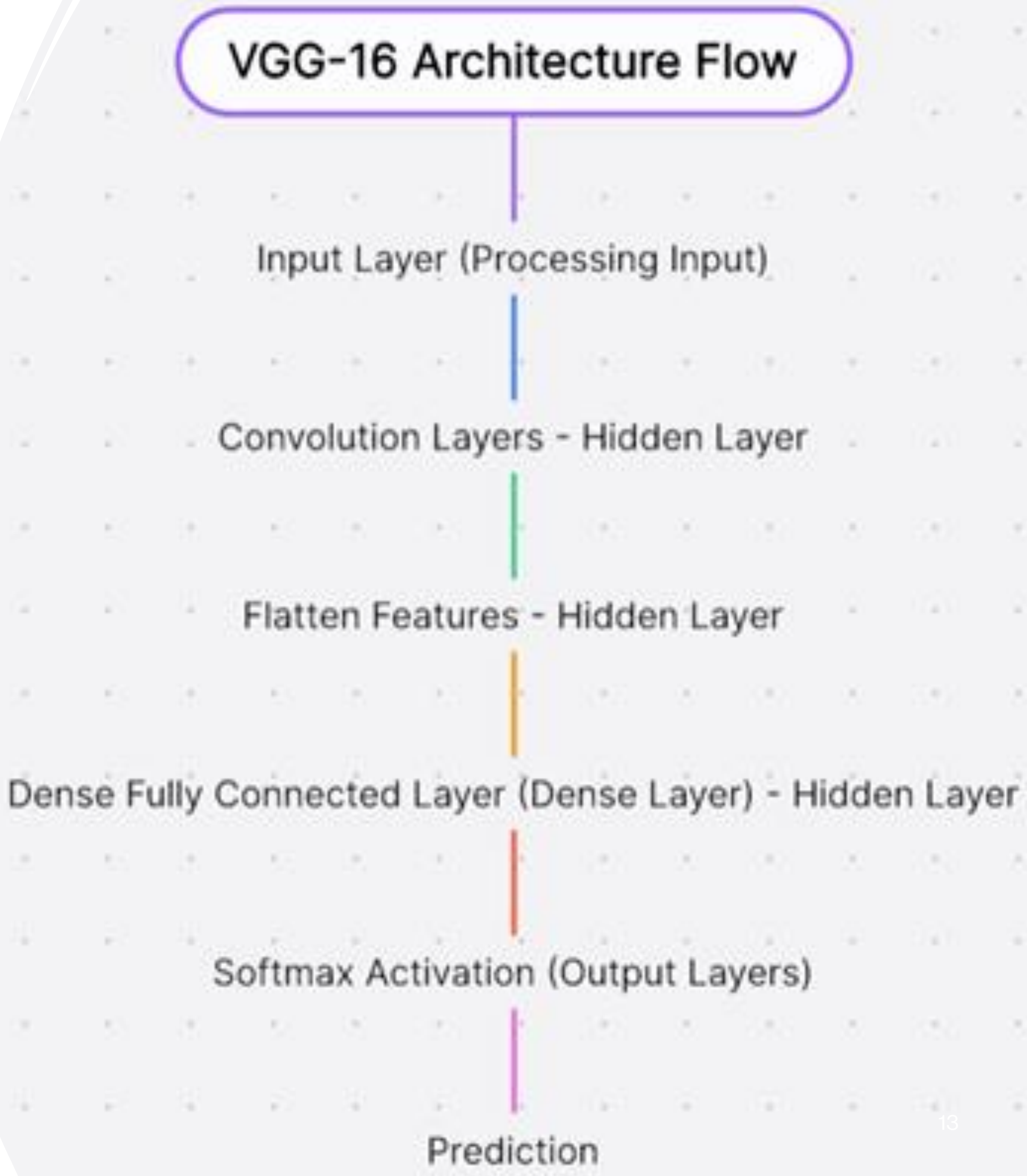
It is widely recognized for its simplicity and effectiveness in image classification tasks.

- The "16" in VGG-16 denotes the total number of weight layers, including 13 convolutional layers and 3 fully connected layers.

- VGG-16 has gained popularity due to its uniform architecture, where convolutional layers are stacked sequentially with small 3x3 filters, followed by max-pooling layers for down sampling.

VGG

- Architecture Flow



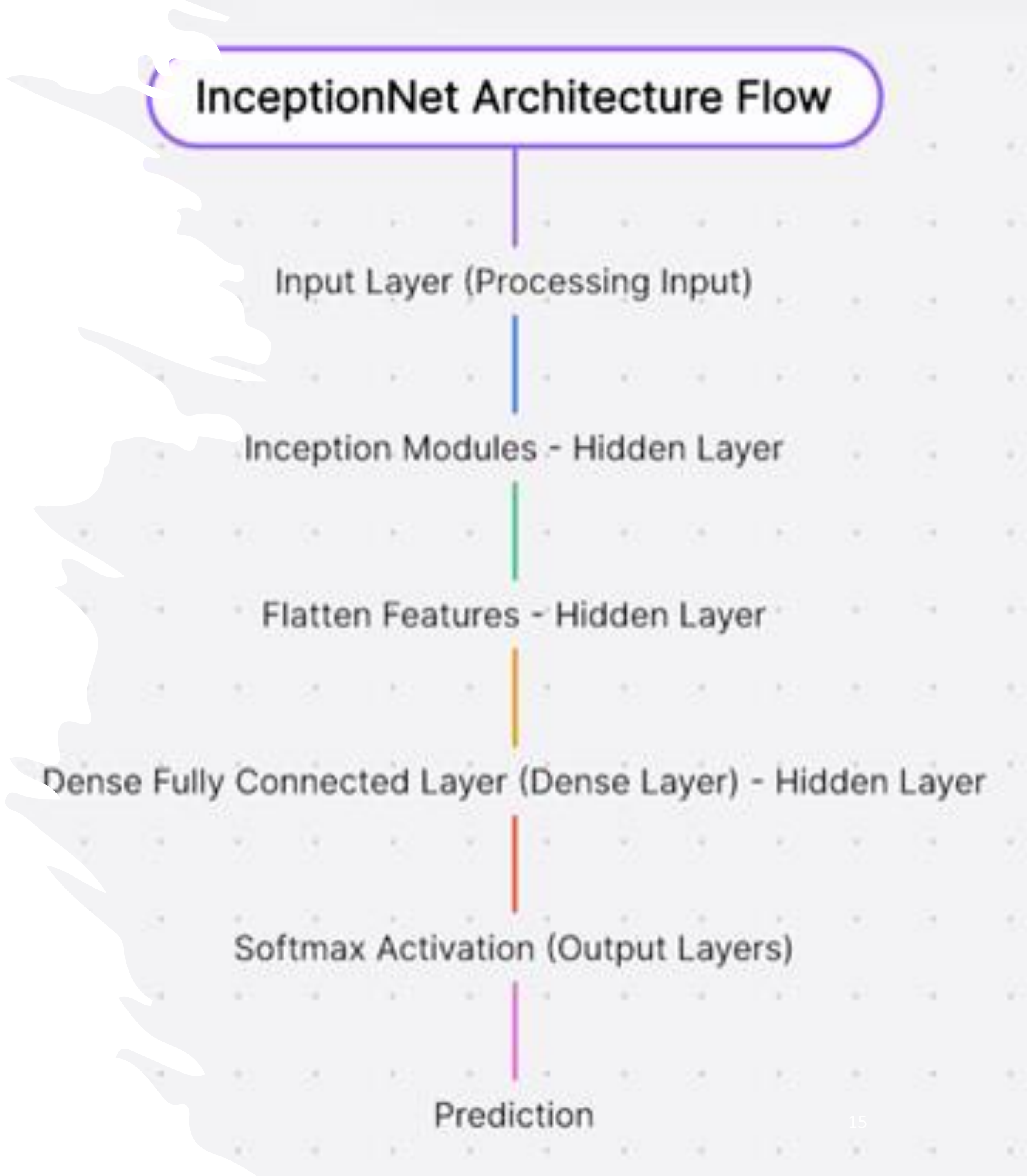
Inception Net

InceptionNet (GoogLeNet) is a deep and wide CNN from Google, known for its efficient feature extraction. It utilizes innovative "inception modules" that perform multiple convolutions in parallel with varying filter sizes.

This unique design allows Inception Net to capture a wider range of features, from localized details to broader patterns, in a single pass. This approach aims to achieve a balance between capturing rich information and maintaining computational efficiency.

Inception Net

- InceptionV3 Workflow



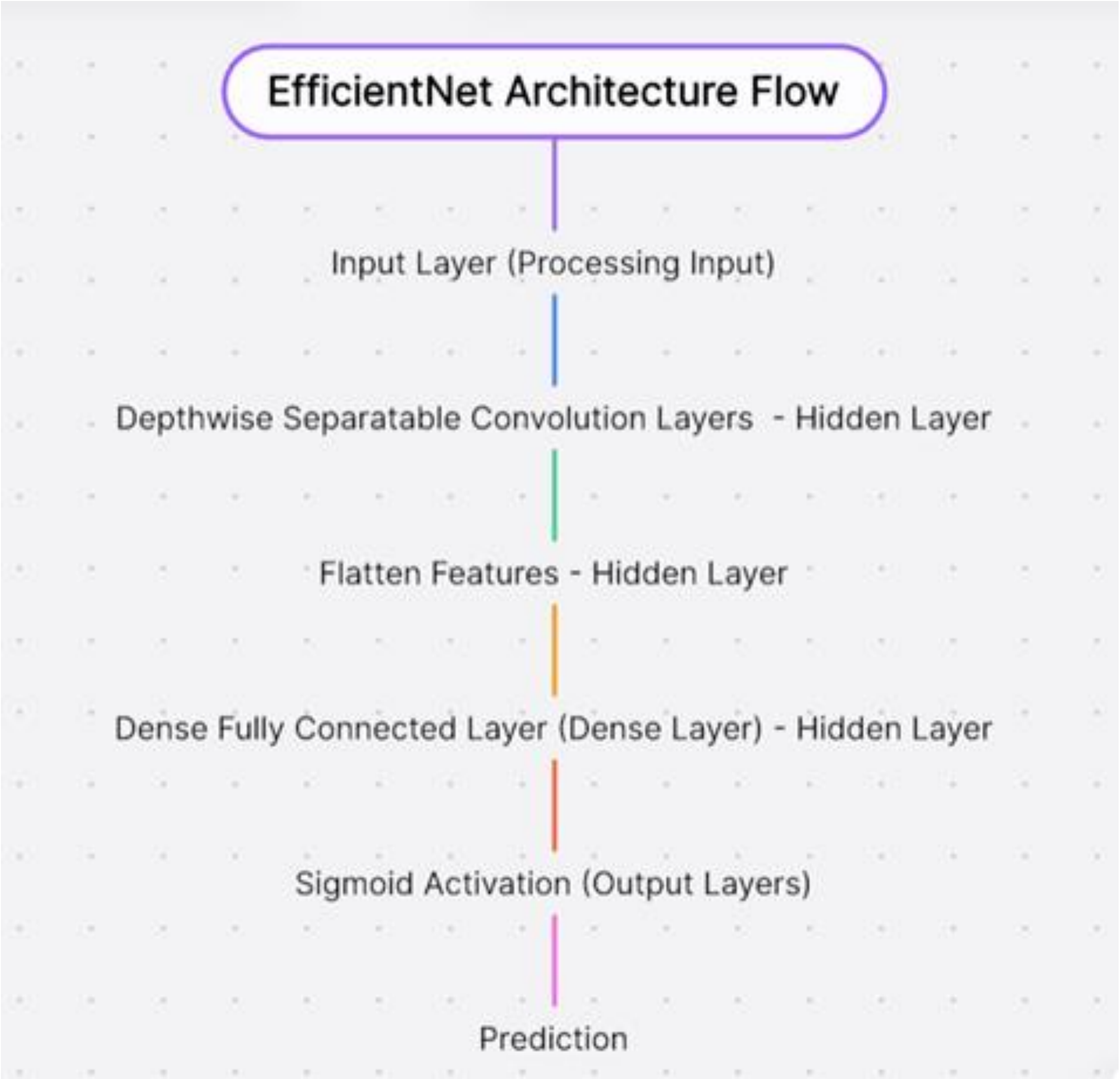
Efficient Net

EfficientNet models are a family of lightweight and scalable convolutional neural networks (CNNs) designed for image classification. They achieve high accuracy while being efficient with parameters and computational resources.

EfficientNet B0 is a lightweight convolutional neural network (CNN) model designed for image classification. It prioritizes efficiency, achieving high accuracy on image tasks while using fewer parameters and computational resources compared to more complex models.

EfficientNet B7 is a powerful image classification model from Google, part of the EfficientNet family. Designed for top performance, it utilizes a large and complex architecture.

Efficient Net



Architectural Comparision

Model	Architecture	Number of Layers
VGG-16	Sequential	16
InceptionNet	GoogLeNet-like	Varies
EfficientNet B0	Efficient Scaling	Varies
EfficientNet B7	Efficient Scaling	Varies
Modified Efficient Net B0 Model	Custom	Varies

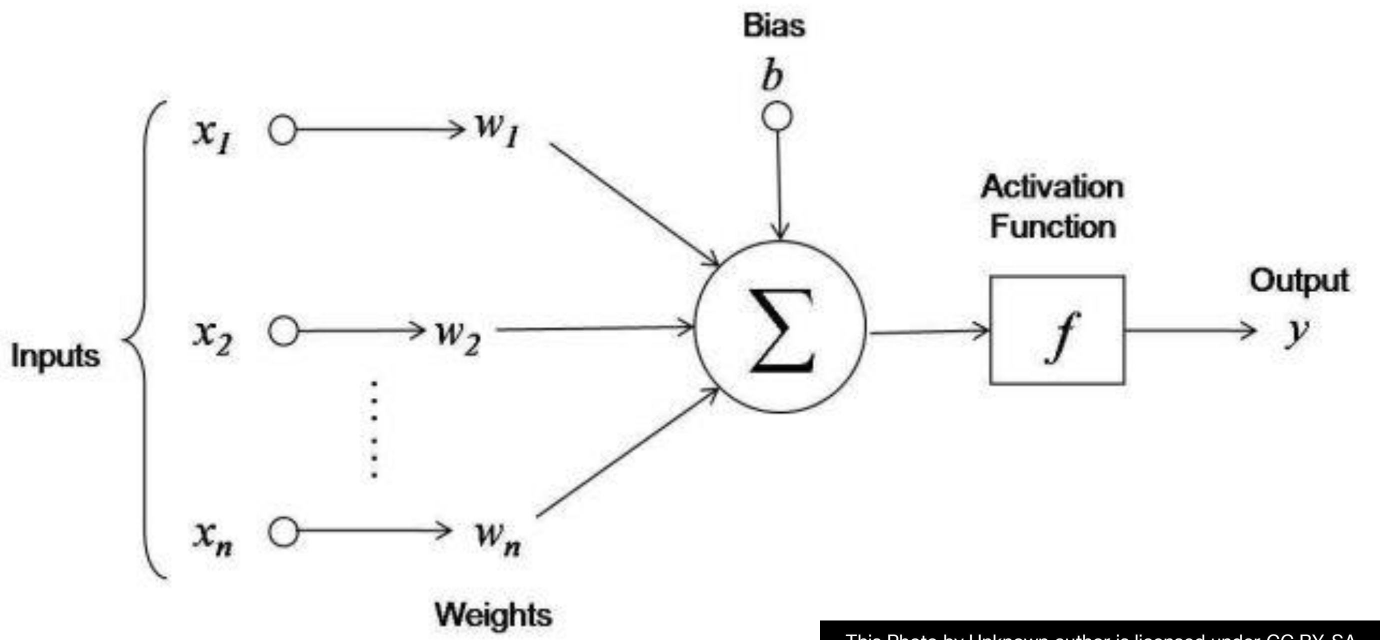
Activation Functions:

Neural networks rely on activation functions, like a switch, to introduce non-linearity and handle complex patterns.

Model	Activation Function	Usage
VGG-16	Softmax	Multi-Class Classification Task
Inception Net	Softmax	Multi-Class Classification Task
Efficient Net B0	Sigmoid	Binary Classification Task
Efficient Net B7	Sigmoid	Binary Classification Task
Modified Efficient Net B0	Sigmoid	Binary Classification Task

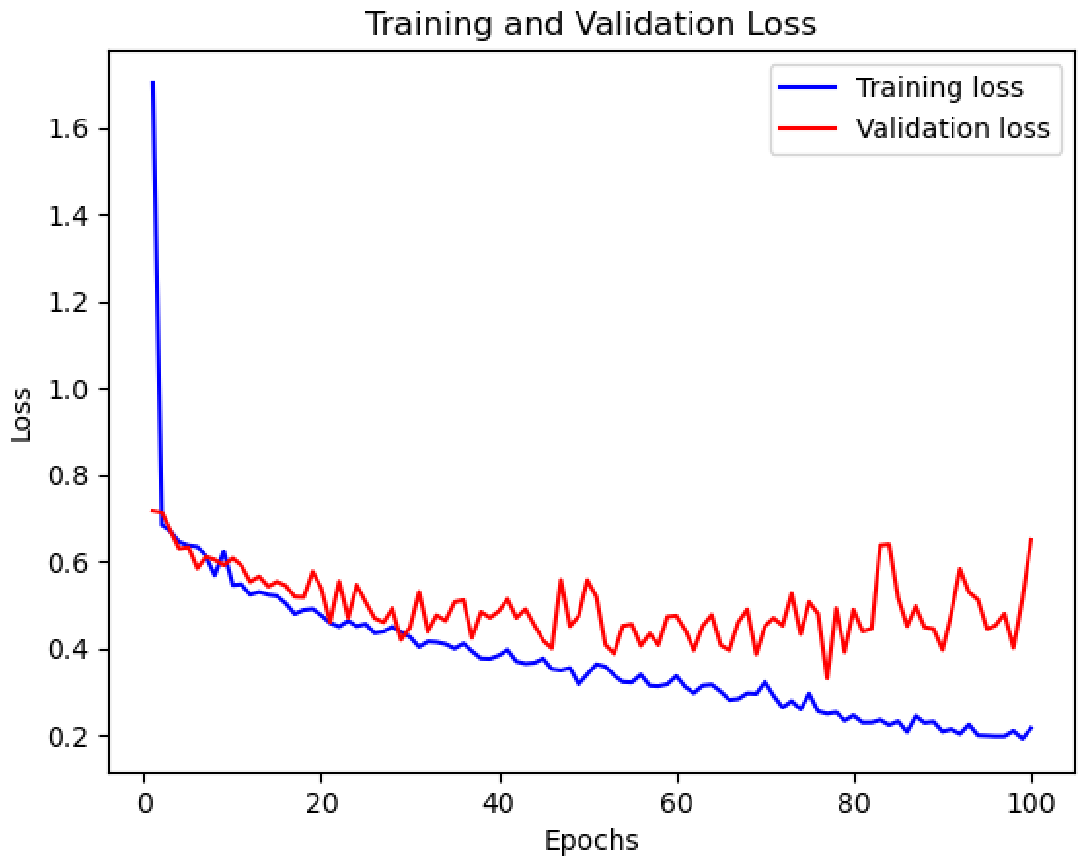
Activation Functions:

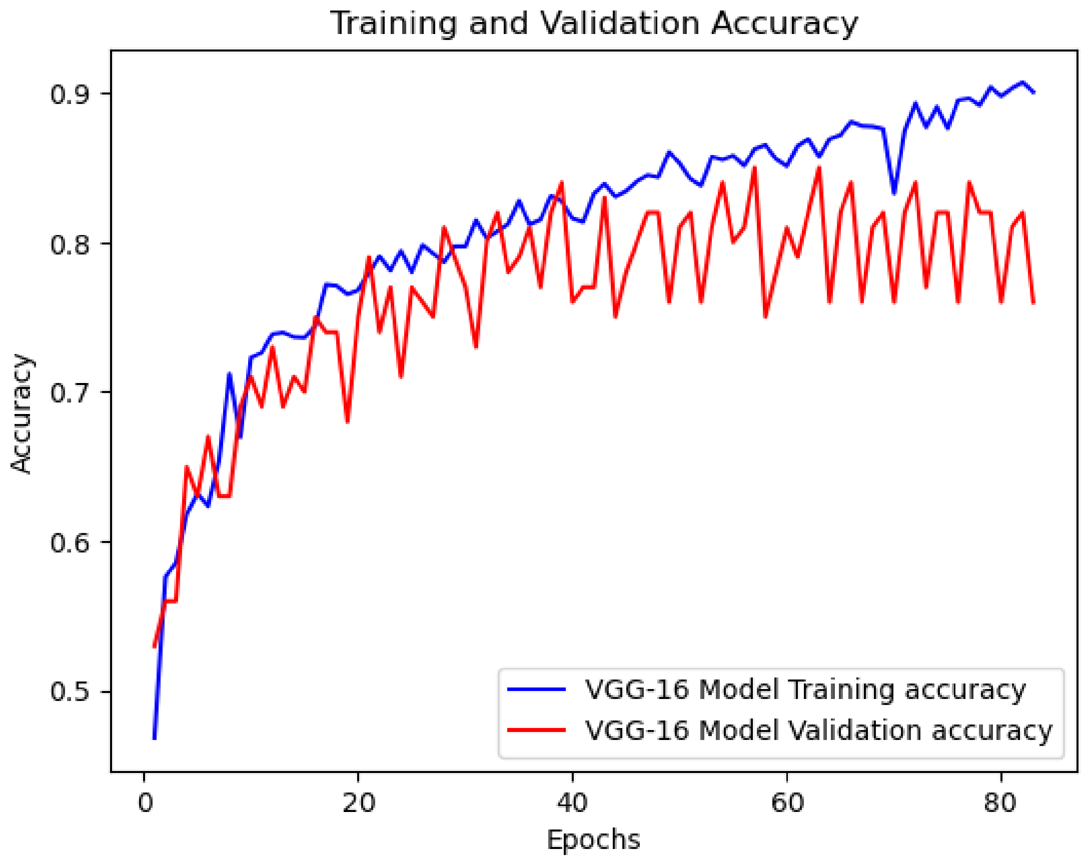
- Sigmoid Activation Function:
  Used for binary classification tasks, where the output needs to be a probability between 0 and 1.
  It squishes any input value into that range, making it suitable for predicting the likelihood of something belonging to one of two classes.
- Softmax Activation Function:
  Used for **multi-class classification tasks**, where there can be more than two possible outputs. Softmax takes a vector of values and transforms them into probabilities that sum up to 1.
  So, it tells us the probability of an input belonging to each of the multiple classes.



Results

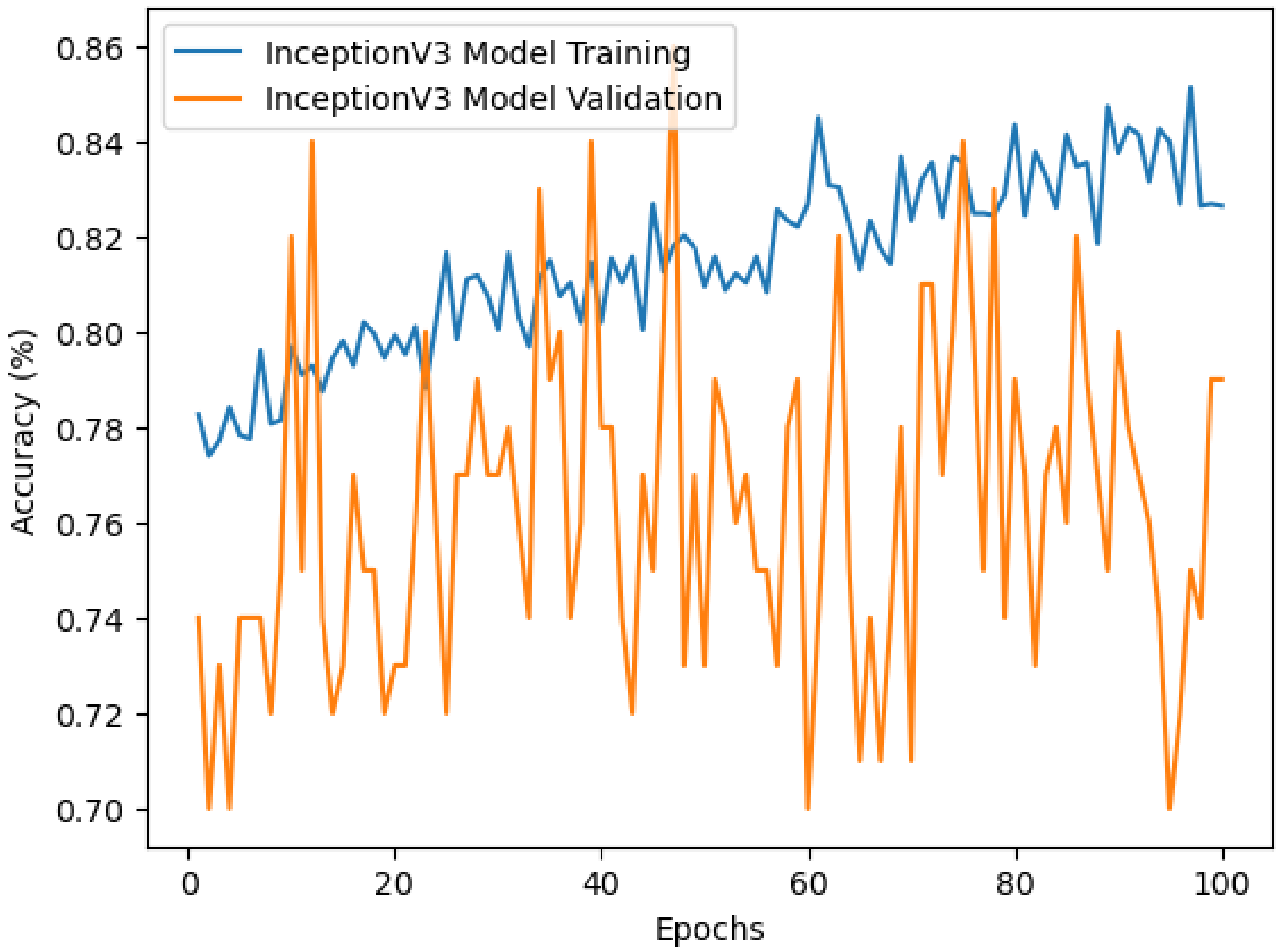
VGG-16





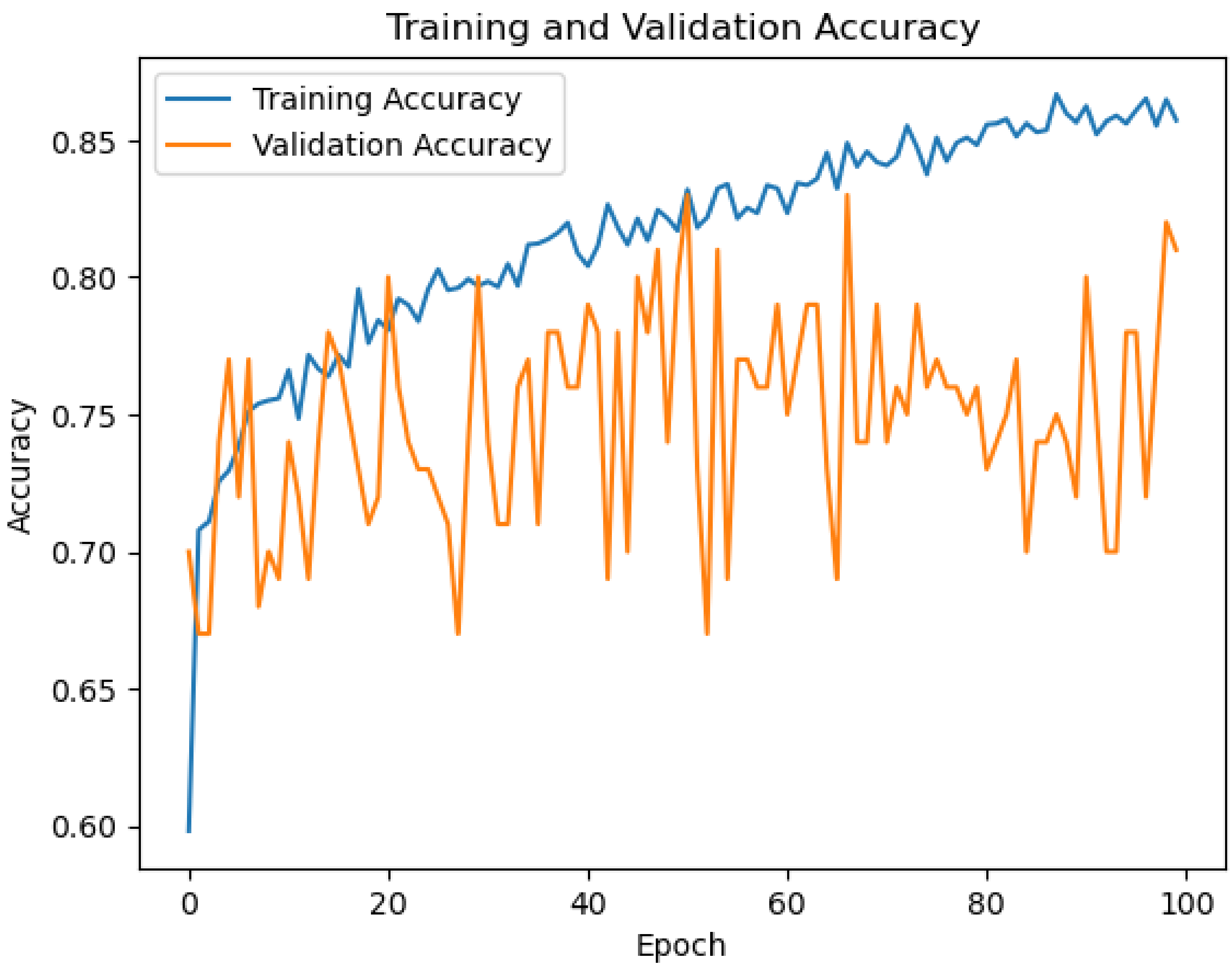
Results

- Inception V3



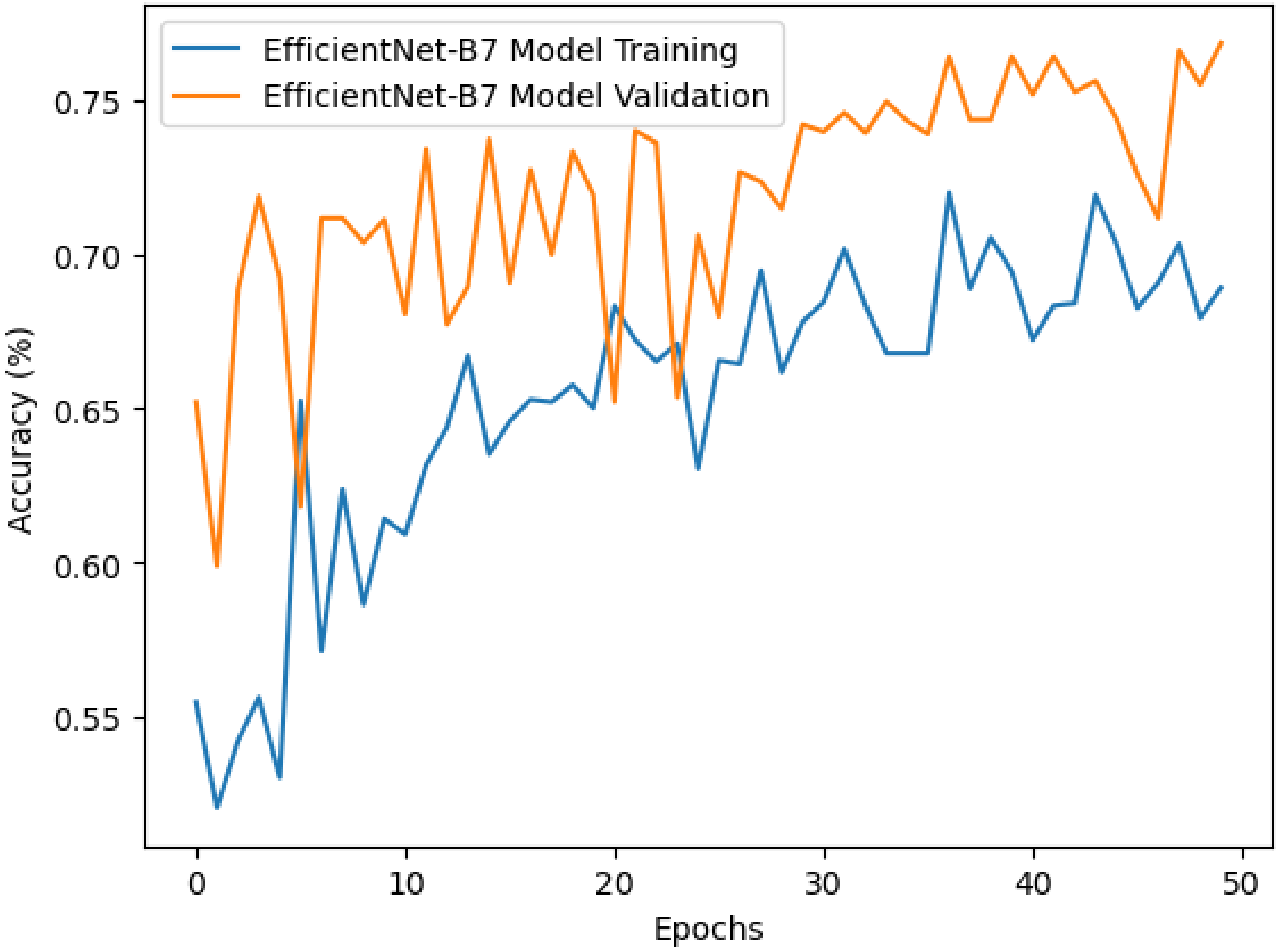
Results

- Efficient Net B0



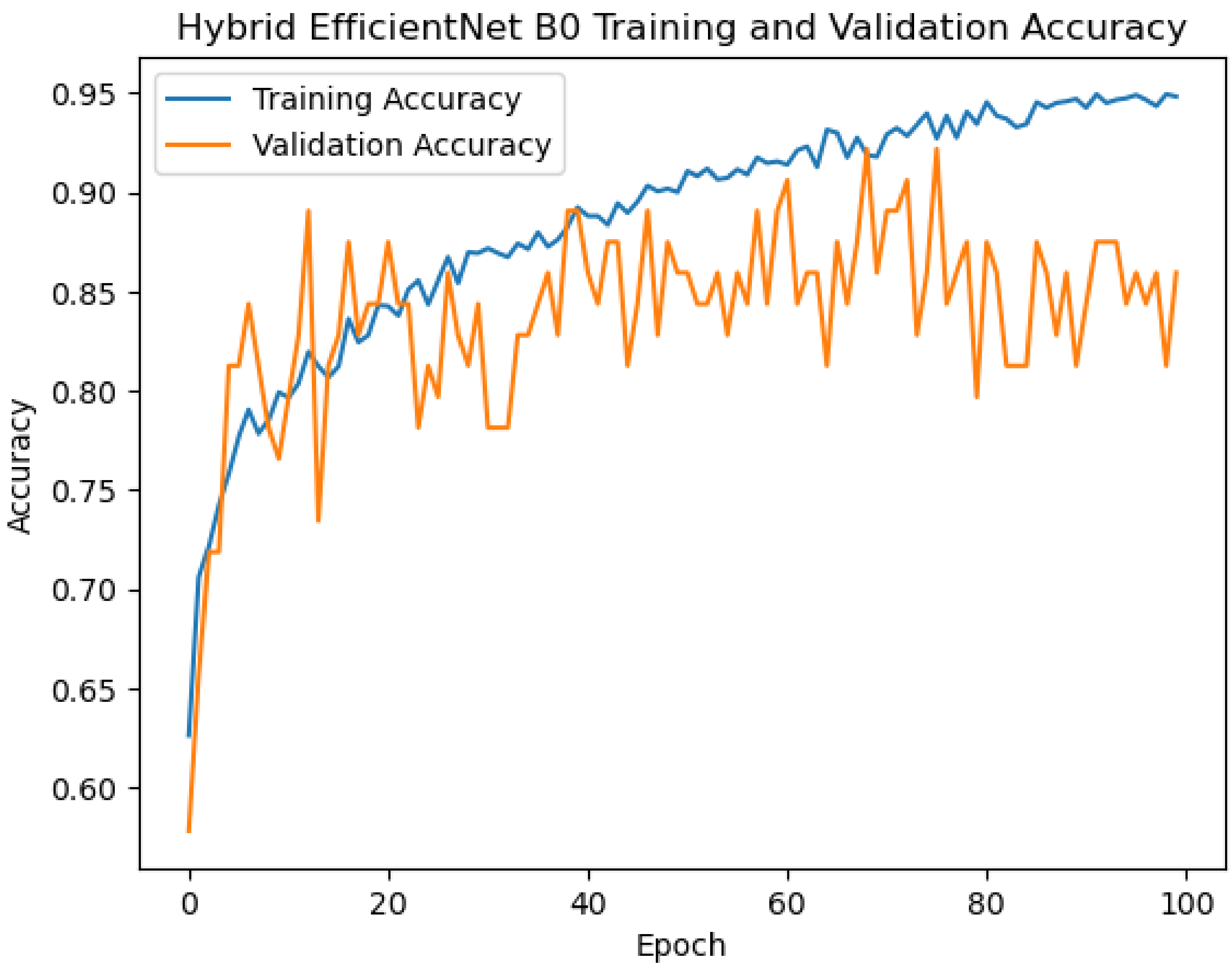
Results

- Efficient Net B7



Results

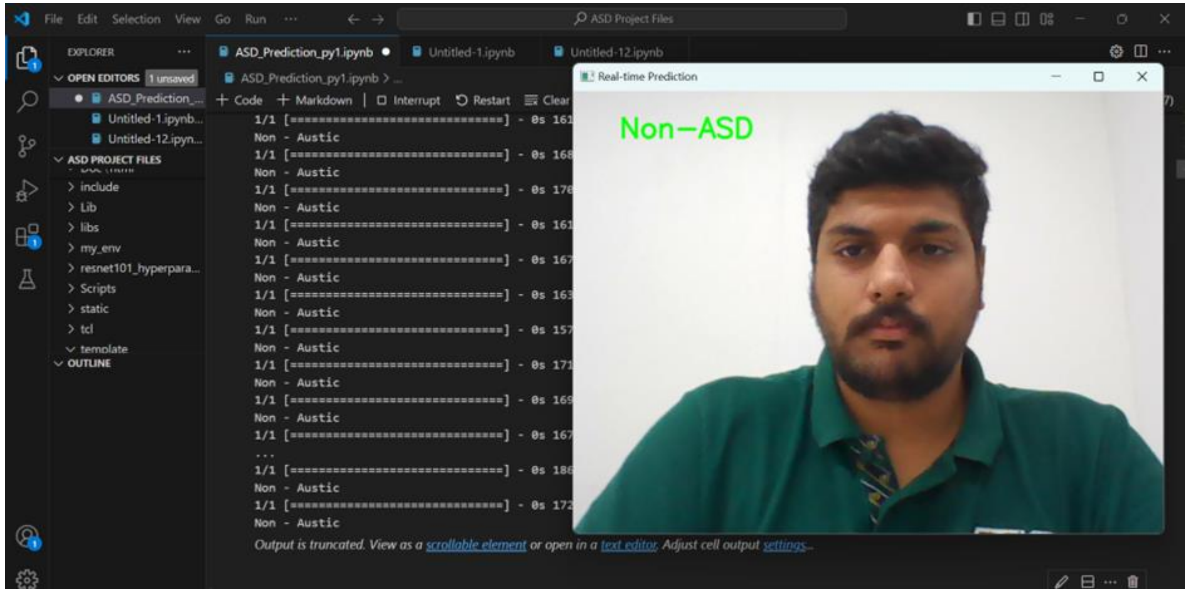
- Hybrid Efficient Net B0

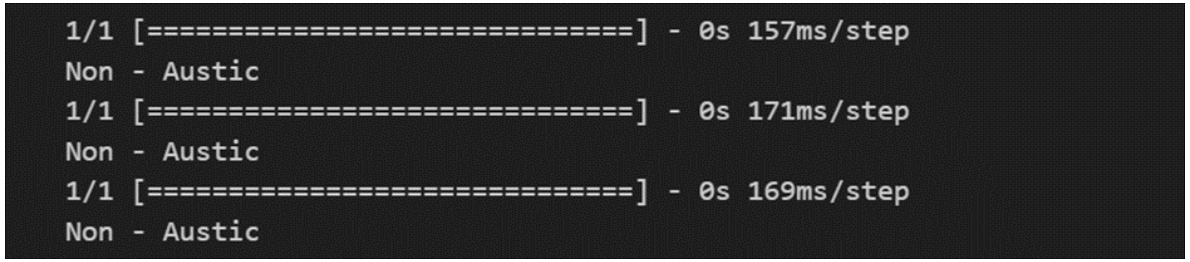


Comparision Table

- Model Accuracy Comparision Table

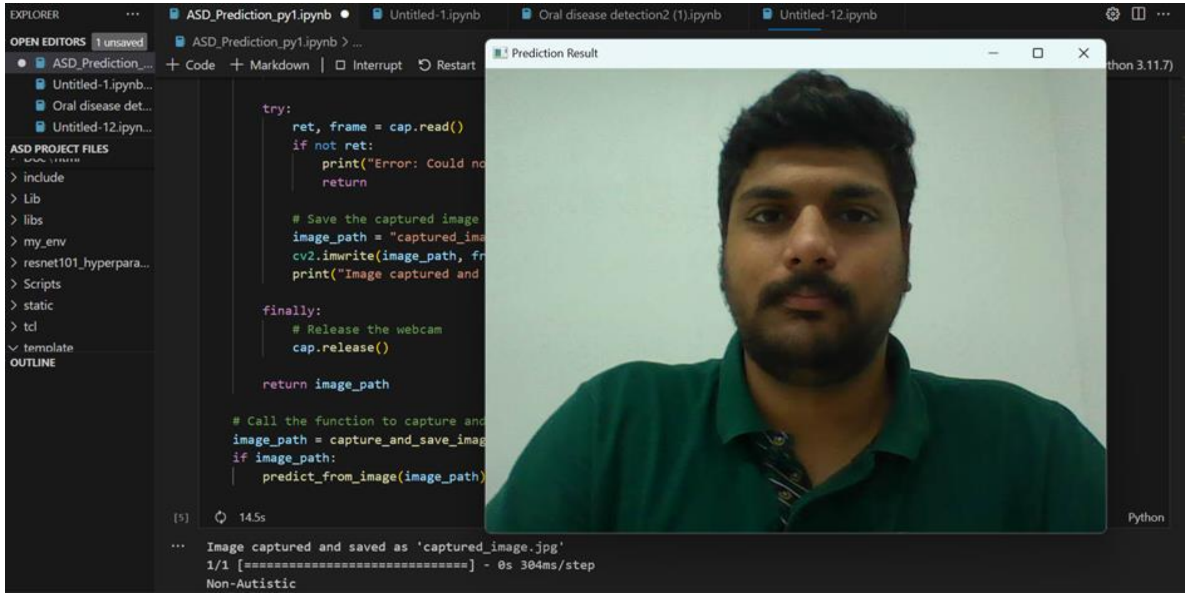
Model	Accuracy	Validation Accuracy
1. VGG-16	90.69%	76.00%
2. Inception V3	82.65%	79.00%
3. EfficientNet B0	85.73%	81.00%
4. EfficientNet B7	68.93%	76.85%
5. Hybrid EfficientNet B0	94.82%	85.94%





Real-Time Search for ASD

Real-Time Capture



References:

1. Autism_Spectrum_Disorder_Detection_in_Children_Using_Transfer_Learning_Techniques
   .
   https://ieeexplore.ieee.org/abstract/document/10212257
2. Autistic_Spectrum_Disorder_Screening_Prediction_with_Machine_Learning_Models
   https://ieeexplore.ieee.org/document/9077881
3. A_Deep_Convolutional_Neural_Network_based_Detection_System_for_Autism_Spectrum_Disorder_in_Facial_images
   https://ieeexplore.ieee.org/document/9641046
4. Analysis and Detection of Autism Spectrum Disorder Using Machine Learning Techniques
   https://www.researchgate.net/publication/340711028_Analysis_and_Detection_of_Autism_Spectrum_Disorder_Using_Machine_Learning_Techniques