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Indian Institute Of Information Technology, Guwahati

# PLANT LEAF DISEASE DETECTION



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# INTRODUCTION



- » India is agriculture dominated country
- » Total Foodgrain production in the country is estimated at record 3296.87 Lakh tonnes in the 2022-23, [click here](#)
- » These crops are threatened by wide variety of plant diseases
- » These can damage the crop, lower the vegetable and fruits quality and wipe out the harvest
- » About 42 percent of the total agricultural crop is destroyed yearly by diseases, [click here](#)

Computer Vision and Image Processing comes into role because:

- » Most plant diseases show **visible symptoms**, and the technique which is accepted today is that an experienced plant pathologist diagnoses the disease through optical observation of infected plant leaves
- » **Drawbacks of pathologist over different techniques of Computer Vision:**
  - Time-consuming process
  - Subjective interpretation of symptoms
  - Limited availability of skilled pathologists
  - Costly for large-scale monitoring



# RELATED WORK



- » The AlexNet is a **8 layers** CNN architecture. On **PLANT VILLAGE** dataset it gives around **89.33 percent** accuracy<sup>[1]</sup>.
- » The VGG16 is a **16 layers** CNN architecture. On **PLANT VILLAGE** dataset it gives around **96.26 percent** accuracy<sup>[1]</sup> 'Emine Uçar'..
- » **InceptionV3** architecture is **48 layers** cnn model but on the same dataset it give accuracy of **96.26 percent**.
- » While increasing the depth of neural networks can potentially capture more complex patterns in data, it also introduces challenges related to **vanishing gradient**.
- » **ResNet50** architecture proposed to solve the problem of multiple non-linear layers not learning identity maps and vanishing gradient problem.

## RELATED WORK(CONTD.)

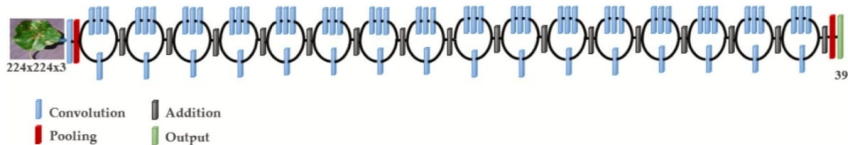


fig 1: ResNet50

- » The ResNet50 is a **50 layers** CNN architecture.
- » On **PLANT VILLAGE** dataset it gives around **95.44 percent** accuracy[1].
- » ResNet (Residual Network) overcomes the problem of vanishing gradients by introducing **skip connections** or **residual connections**.
- » Can we further improve the accuracy.....

# COMPOUND SCALING

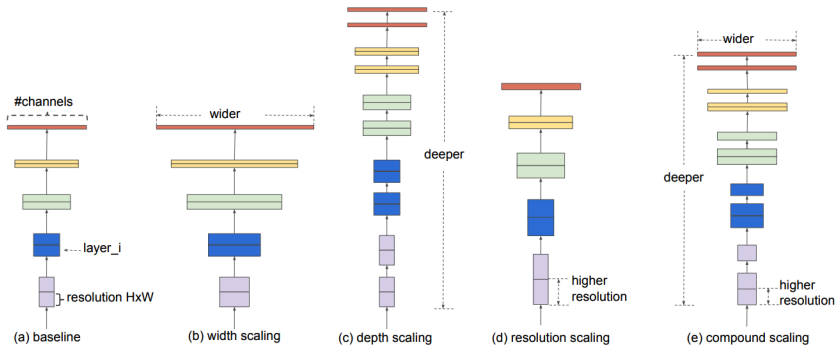


fig 2: Scaling Model

- » Depth scaling involves increasing the number of layers in a neural network.
- » Width scaling involves increasing the number of channels or filters in each layer of a neural network.
- » Resolution scaling involves adjusting the input resolution of the neural network[2].



# COMPOUND SCALING(CONTD.)

- » Depth scaling aims to increase the model's capacity to capture complex patterns by adding **more layers**.  
depth scaling
- » Width scaling focuses on increasing the information capacity at each layer by adding **more channels**.  
width scaling
- » Resolution scaling adapts the network to different input resolutions, capturing **finer details or complex features in the data**.  
resolution scaling
- » Scaling up any dimension of network width,depth or resolution improves accuracy, but accuracy gain diminishes for bigger models.
- » In order to pursue better accuracy and efficiency, it is critical to **balance all dimesions of network width,depth and resolution during scaling**.

# EFFICIENTNET

- » To scale the depth,width and resolution , a baseline model is needed which is called "**EfficientNet Bo**".
- » Baseline network developed using a **Neural Architectural Search(NAS)**, then scaled up the baseline network to generate a series of models called as "**EfficientNets**",**B1 to B7**[2].

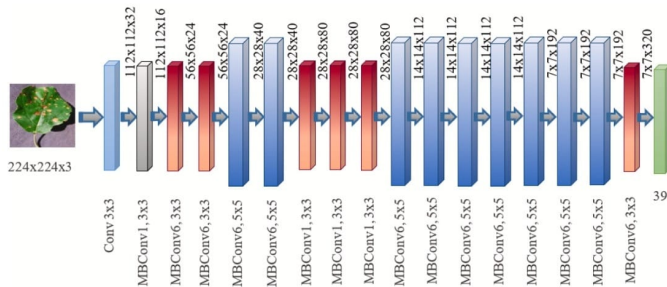


fig 3: EfficientNet(Bo)

# EFFICIENTNET(CONTD.)



- » The **MBConv block**, used in EfficientNet, uses the inverted residual block and includes a squeeze and excitation(SE) module to improve its representational power.
- » Expansion Phase → Depthwise Convolution → Batch Normalization → Squeeze and Excitation(SE) module → Skip Connection
- » In the expansion phase, the number of channels is increased using a 1x1 convolutional layer.
- » Depthwise convolution applies a separate convolutional filter for each input channel. It helps in reducing computational cost and model size by applying convolutions independently across channels.
- » Batch normalization is a technique used to address the issue of internal covariate shift. The SE module is integrated into the MBConv block to enhance its representational power. It adaptively recalibrates channel-wise feature responses by explicitly modeling interdependencies between channels.

# COMPARISON



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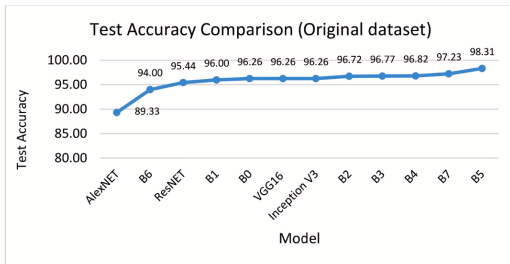


fig 4: Test Accuracy

Model name	Input size	Number of total parameters
AlexNet	227 × 227	60,954,656
ResNet50	224 × 224	25,636,712
VGG16	224 × 224	138,357,544
Inception V3	299 × 299	23,851,784
EfficientNet	B0	224 × 224
	B1	240 × 240
	B2	260 × 260
	B3	300 × 300
	B4	380 × 380
	B5	456 × 456
	B6	528 × 528
	B7	600 × 600
		66,658,687

fig 5: No.Of Parameters analysis

- » These results obtained after training all models on PLANT VILLAGE dataset[1].
- » EfficientNet B5 exhibits the highest accuracy, while considerations such as overfitting and hyperparameter tuning become more prominent factors for models B6 and B7.

# COMPARISON(CONTD.)

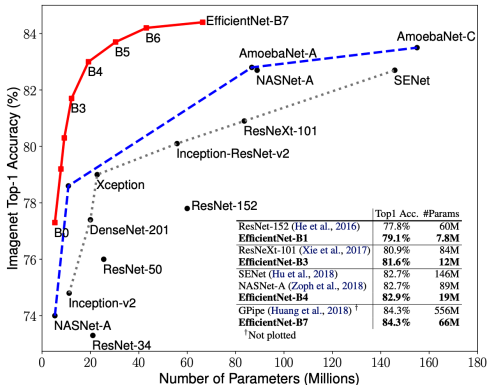


fig 6: Different Models Analysis

- » These results obtained after training all models on **Imagenet** dataset.
- » Here, B6 and B7 gives higher accuracy than B5.
- » The number of parameters increases as depth, width, and resolution scale up, impacting computational complexity and memory requirements in the transition from EfficientNet B0 to B1[2]..

# FURTHER IMPROVMENT

## ATTENTION MECHANISM

- » The attention mechanism enables the network to selectively emphasize important features while suppressing irrelevant ones, leading to more efficient use of computational resources.
- » The attention mechanism facilitates faster convergence during training by directing the learning process towards the most informative features, leading to improved efficiency in terms of both time and computational resources.

## TRANSFER LEARNING

- » Transfer Learning is a research problem in machine learning that focuses on storing knowledge gained while solving one problem and applying it to a different but related problem.
- » Integrate transfer learning by initializing pre-trained model, then **fine-tuning or feature extraction** on new plant leaf datasets, leveraging existing learned features to boost accuracy and adaptability.

## » Soynet:

- Indian Soybean Image dataset with quality images captured from the agriculture field ( healthy and diseased Images).
- Raw dataset and preprocessed dataset with a resolution of 256x256 pixels present in the dataset.
- This dataset consists of 9000+ high-quality images of soybeans (healthy and Disease quality).

[click here](#)

## » Dataset for Crop Pest and Disease Detection:

The dataset is presented in two folds

- The raw images which consists of 24,881 images ( 6,549-Cashew;7,508-Cassava;5,389-Maize and 5,435-Tomato).
- Augmented images which is further split into train and test set consists of 102,976 images (25,811-Cashew; 26,330-Cassava;23,657-Maize and 27,178-Tomato), categorized into 22 classes

[click here](#)

# RESULTS

	no. of parameters	accuracy
basic	7,842,762	75.66
alexnet	58,437,030	78.63
vgg16	151,512,972	–
EfficientNet Bo	40,91,454	–

- » Vanishing Gradient implementation using the deep network.
- » Difference of softmax and relu function on vanishing gradient.



# REFERENCES



- » **[1]** Atila, Ümit, Murat Uçar, Kemal Akyol, and Emine Uçar. "Plant leaf disease classification using EfficientNet deep learning model." Ecological Informatics 61 (2021): 101182.
- » **[2]** Tan, Mingxing, and Quoc Le. "Efficientnet: Rethinking model scaling for convolutional neural networks." In International conference on machine learning, pp. 6105-6114. PMLR, 2019.
- » **[3]** Lu, Jinzhu, Lijuan Tan, and Huanyu Jiang. "Review on convolutional neural network (CNN) applied to plant leaf disease classification." Agriculture 11.8 (2021): 707.