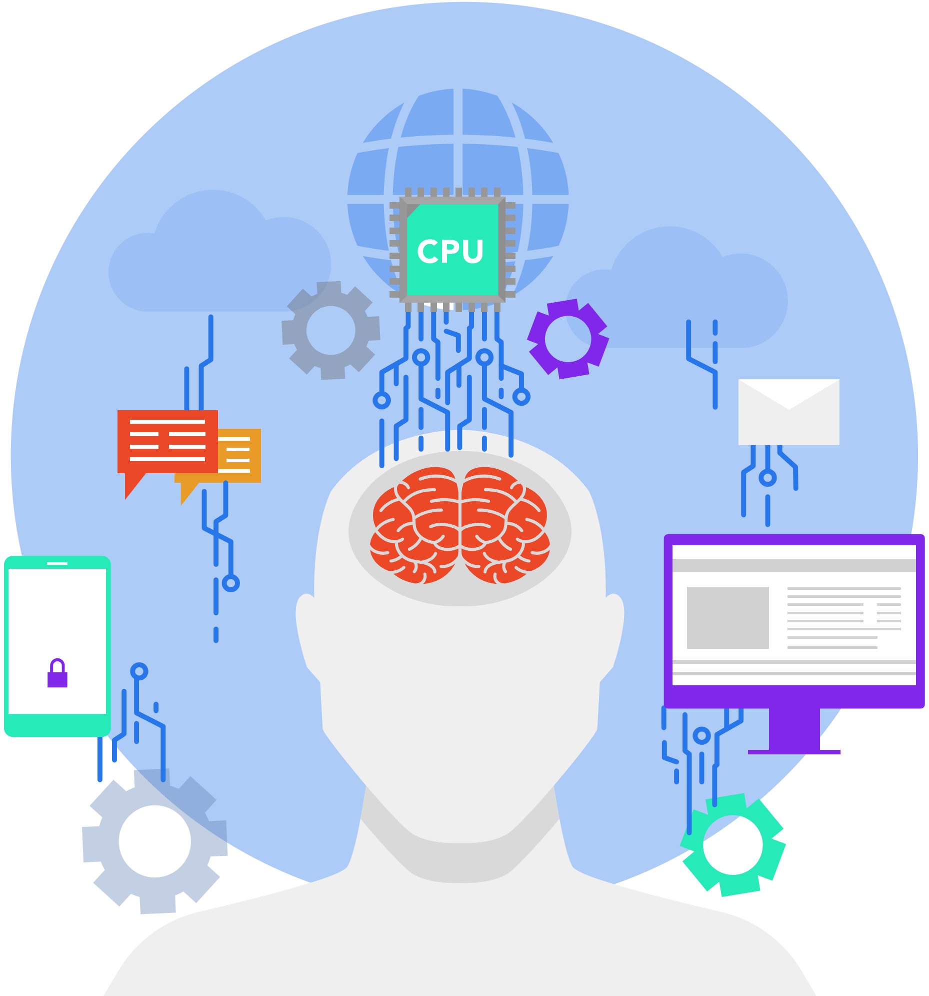
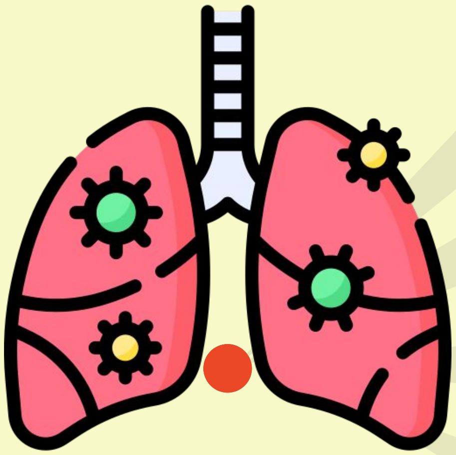


Group P

Pneumonia Detection from Chest X-Rays using CNN

Team Details:
Konark shah: 40232277
Vandit Mehta: 40232414
Urvilkumar Patel: 40230360
Anurag Teckchandani: 40263724

Pneumonia Detection as a Problem and its Importance



Serious Respiratory Infection

Leading cause of morbidity and mortality worldwide.

Complex Diagnosis

Diagnosis can be difficult due to shared symptoms.

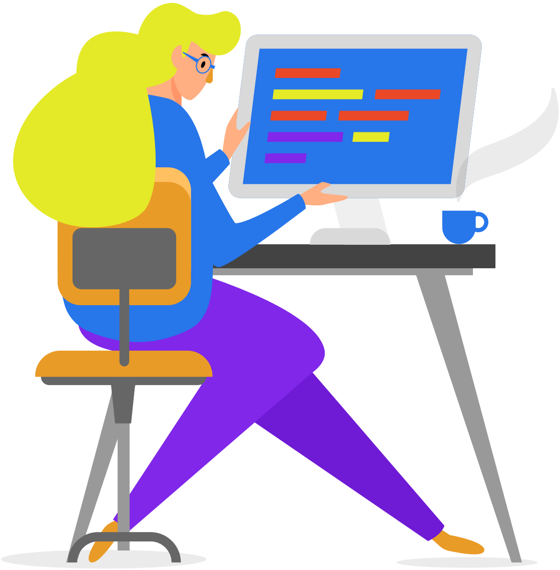
Shortage of Professionals

Dependent on expert interpretation and medical access.

Potential AI solutions

AI adoption challenges: dataset diversity, model interpretability, and generalizability.

Goals of the Project



01

Create an AI system for pneumonia detection using CNNs on chest X-rays.

02

Address the challenge of accurate pneumonia diagnosis, especially in resource-constrained healthcare settings.

03

Assess CNN performance (ResNet18, DenseNet121, InceptionV3) across diverse datasets using multiple metrics.

04

Enhance healthcare and patient outcomes with improved pneumonia detection through AI.

Methodology: Used Datasets

	Details of Each Datasets of the Project	
01	Dataset 1	• Categories: Pneumonia and Normal • Resolution: 1120 x 800 pixels • Training: 3,514 images • Validation: 878 images • Testing: 1,464 images
02	Dataset 2	• Categories: Bacterial, Covid-19, Lung Opacity, Normal, Viral • Resolution: 1780 x 1800 pixels • Training: 2,020 images • Validation: 500 images • Testing: 1,035 images
03	Dataset 3	• Categories: 14 lung disease classes including pneumonia • Resolution: 1024 x 1024 pixels • Training: 67,272 images • Validation: 16,818 images • Testing: 28,030 images

Methodology: CNN Models

ResNet18

- Addresses vanishing gradient issue
- 18 layers Architecture
- Parameters: ~11.7M
- Input image size: 224x224 pixels
- FLOPS: Approximately 1.8 billion

Vs

Inception-V3

- Utilizes filters with multiple sizes for wider networks
- Approximately 23.8 million parameters
- Input image size: 299x299 pixels
- FLOPS: Approximately 5.7 billion

Vs

DenseNet121

- Chosen for dense connectivity promoting reuse
- 121 layers Architecture
- Parameters: ~7.0M
- Input image size: 224x224 pixels
- FLOPS: Approximately 2.9 billion

Methodology: Optimization Algorithm

01 Utilized Stochastic Gradient Descent (SGD) optimization algorithm

02 SGD updates parameters by subtracting a fraction of loss gradient.

03 Momentum value of 0.9 set for accelerated convergence

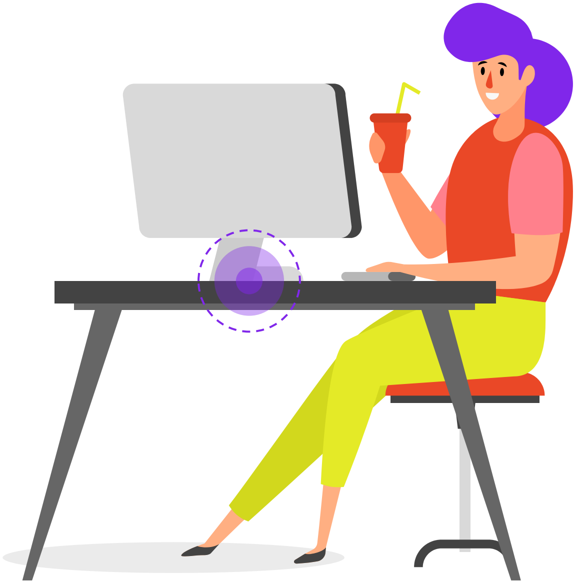
04 Learning rate of 0.001 varied to optimize model convergence

05 Loss function: Cross entropy loss

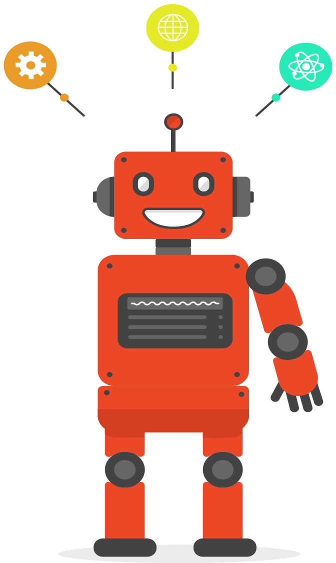
06 Evaluation metrics: Accuracy, Precision, Recall, F1-score

07 Utilized t-SNE for visual comparison of feature distributions in lower-dimensional space

08 Model hyperparameters:
Optimizer: SGD
Learning rate: 0.001
Batch size: 30
Loss function: Cross entropy loss
Number of epochs: 30



Experimental Setup



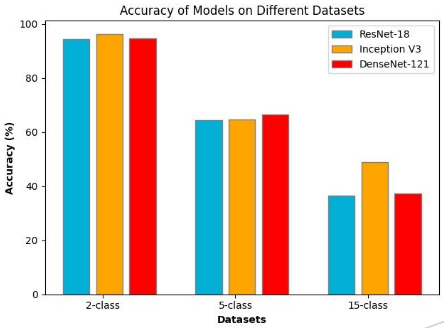
01 Data from three Kaggle sources was preprocessed: cleaned, resized, and converted to PIL Image format and torch.float32.

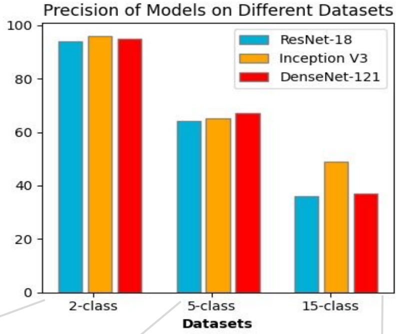
02 Dataset split into 60:15:25 ratios for training, validation, and testing.

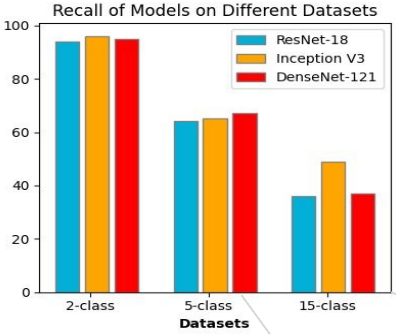
03 Data augmentation techniques, including normalization, were applied during training.

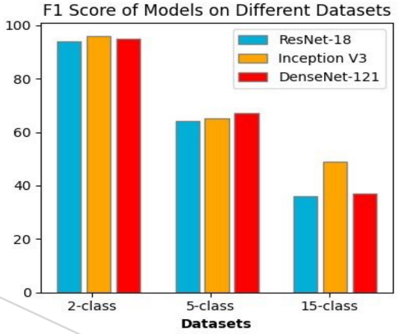
04 Utilized SGD, ReLU, and optimized hyperparameters; evaluated using accuracy, loss, and confusion matrices on validation/test data.

Main Results









01

Inception v3 consistently outperforms ResNet-18 and DenseNet-121 across all datasets

02

Accuracies of 96.39%, 64.63%, and 49.02% for Inception v3, and 94.35%, 64.44%, and 36.43% for ResNet-18 and DenseNet-121.

03

Performance declines as the number of classes in the dataset increases.

04

Inception v3 demonstrates the highest accuracy across datasets, while ResNet-18 tends to overfit.

05

Inception v3 demonstrates the highest accuracy across datasets, while ResNet-18 tends to overfit.

Hyper Parameter Tuning and Ablative Study

01 Hyperparameter Tuning

- Learning rate adjustment crucial for model convergence.
- Optimal learning rate for ResNet-18 on a 5-class dataset was 0.001, with limited computational resources preventing further hyperparameter fine-tuning.

02 Transfer Learning

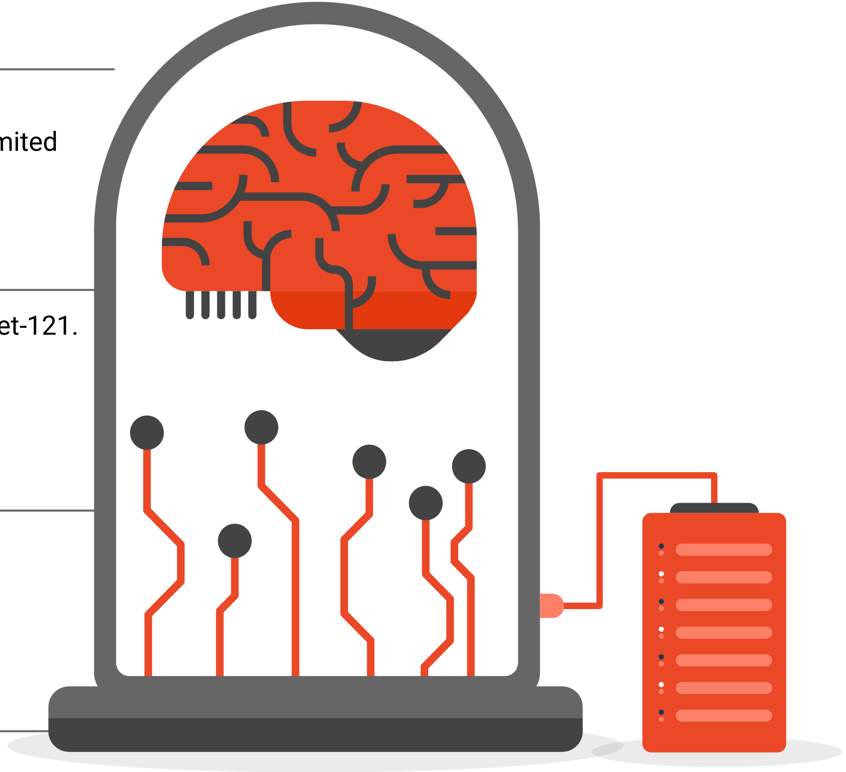
- Pretrained weights from IMAGENET1K V1 used for ResNet-18 and DenseNet-121.
- Pretrained models improve initial accuracy and convergence speed, while overfitting is countered with regularization and data augmentation.

03 Feature Understanding using t-SNE

- t-SNE visualization reveals class clusters and overlap.
- Pretrained weights lead to more generalized but less distinct feature representations.

04 Ablative Study

- Learning Rate Finder tool identifies optimal learning rate of 0.001.
- Performance metrics inversely correlate with the number of classes in the dataset.



References

1. Varshni, D., Thakral, K., Agarwal, L., Nijhawan, R., Mittal, A. (2019). Pneumonia Detection Using CNN-based Feature Extraction. IEEE International Conference on Electrical, Computer and Communication Technologies (ICECCT), 2019. Coimbatore, India. pp. 1-7. doi: 10.1109/ICECCT.2019.8869364.
2. Xie, S., Girshick, R., Doll´ar, P., Tu, Z., He, K. (2017). Aggregated residual transformations for deep neural networks. In Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition, Honolulu, HI, USA, 21–26 July 2017; pp. 1492–1500. IEEE.
3. Huang, G., Liu, Z., Van Der Maaten, L., Weinberger, K.Q. (2017). Densely connected convolutional networks. In Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition, Honolulu, HI, USA, 21–26 July 2017; pp. 4700–4708. IEEE.
4. Szegedy, C., Vanhoucke, V., Ioffe, S., Shlens, J., Wojna, Z. (2016). Rethinking the inception architecture for computer vision. In Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition, Las Vegas, NV, USA, 27–30 June 2016; pp. 2818–2826. IEEE.
5. Vantaggiato, E.; Paladini, E.; Bougourzi, F.; Distante, C.; Hadid, A.; Taleb-Ahmed, A. COVID-19 Recognition Using Ensemble-CNNs in Two New Chest X-ray Databases. Sensors 2021, 21, 1742. https://doi.org/10.3390/s21051742
6. Elgeldawi, E.; Sayed, A.; Galal, A.R.; Zaki, A.M. Hyperparameter Tuning for Machine Learning Algorithms Used for Arabic Sentiment Analysis. Informatics 2021, 8, 79. https://doi.org/10.3390/informatics8040079
7. Suhirman, Suhirman & Rianto, Rianto & Santosa, Paulus & Yunanto, Rio. (2023). THE ENSEMBLE METHOD AND SCHEDULED LEARNING RATE TO IMPROVE ACCURACY IN CNN USING SGD OPTIMIZER. Journal of Engineering Science and Technology. 18. 2779-2792.
8. Tyagi, Arnav & Khandelwal, Rishabh & Shelke, Nitin & Singh, Jagendra & Rajpal, Dev & Gaware, Ishaan. (2024). Comparitive Analysis of Various Transfer Learning Apporaches in Deep CNNs for Image Classification. 10.1007/978-3-031-53082-127.
9. Prathivi, Rastri. (2020). The Optimization of Transfer Learning Convolutional Neural Network Model with PCA and t-SNE Algorithms for Classification and Recognition of CIFAR-10 Image. Jurnal RESTI (Rekayasa Sistem dan Teknologi Informasi). 4. 717-722. 10.29207/resti.v4i4.2131.

THANK YOU