**A DEEP UNET SEGMENTATION ON LOW DOSE CT TOWARDS THE DETECTION OF LUNG NODULE CANCER**

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**ABSTRACT**

This research paper delves into the advancement and analysis of image segmentation, a field with a rich history of exploration. It conducts a comparative analysis of various architectural paradigms, including U-Net, DenseNet, AlexNet, CoatNet, and VGG19. Through meticulous experimentation conducted in Python, the study aims to ascertain the efficacy of these architectures, striving to identify the most promising approach. The outcomes and implications drawn from the results pave the way for future avenues of research and development.

**Introduction**

Lung cancer is one of the hazardous and most common cancers reported globally and is the leading cause of cancer related deaths. There were an estimation of 20 million cases and 9.7 million deaths. The estimated number of people who were alive within 5 years following a cancer diagnosis was 53.5. when calculated among both genders, 1 in 9 men and 1 in 12 women die from the disease.

This research paper ranges over the application of deep learning methods in the realm of lung cancer detection focusing to upgrade the accuracy and efficiency of diagnosis. The study exploits the dataset (LIDC-IDRI) with various deep learning segmentation models. Our work emphasizes Region of Interest (ROI) prioritization to enhance lung nodule detection efficiency. Utilizing a deep learning model, our approach precisely segments images to identify malignancies.

In the field of medical imaging, image segmentation holds a significant value as it yields reliable and highly accurate results. This technique is popularly used across various image modalities such as CT and MRI scans. The core objective is to transform an image into more comprehensive and meaningful representation that streamlines easy analysis.by extracting Region of Interest (ROI). By splitting the images into certain parts, it simplifies the following processing tasks. These segmented tasks when regathered form a full image. Despite the availability of numerous segmentation methods, their performance can vary significantly.

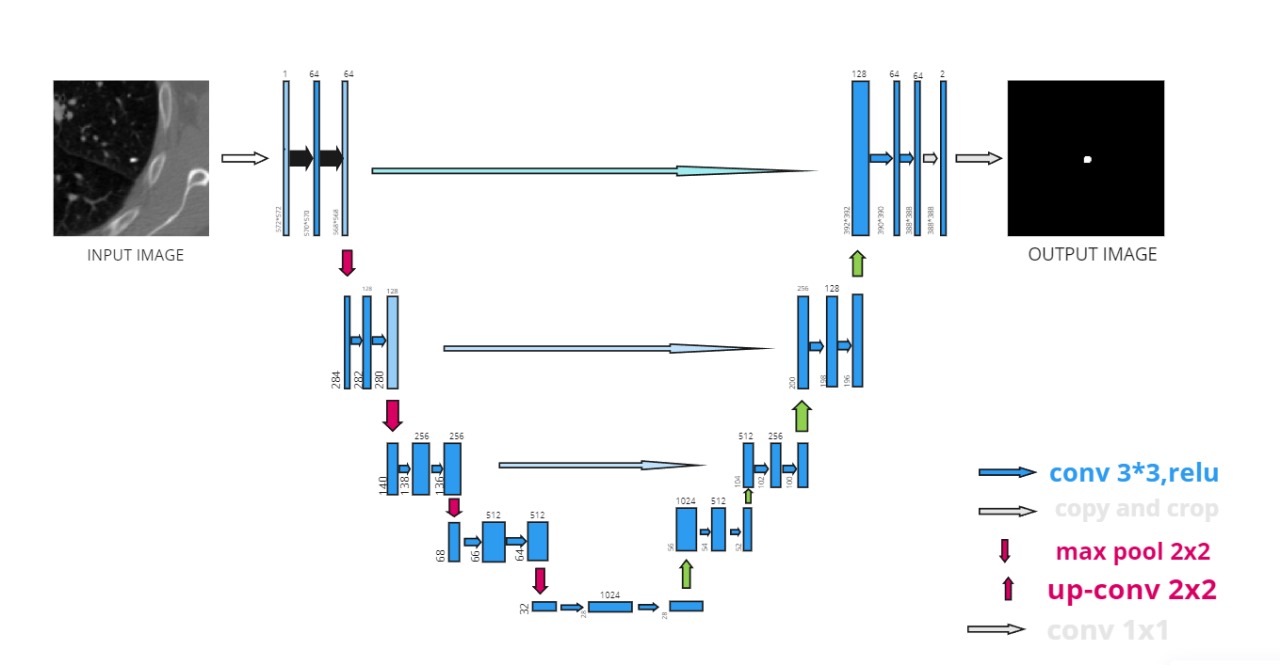
Moreover our research project aims to compare the performance of various deep learning models. The deep learning models used for image processing is called Convolutional neural network (CNN). Models of this kind are deployed on dedicated graphics processing unit (GPUs) to mitigate latency and foster quick and easier computational process.

Each patient’s record images have been sliced to reduce image artifacts and provide clear insight into the analysis of affected areas. The primary objective is to determine the top-performing model among the five deep learning models.

**ARCHITECTURE OF NEURAL NETWORKS**

Neural networks are detailed systems comprising multiple inputs processed by artificial neurons to deliver a single output. The five types of architectures used in this project are as follows: U-Net, DenseNet, AlexNet, VGG19 and CoatNEt.

**U-Net**U-net is a convolutional neural network initially tailored for biomedical image segmentation, has been designed to work effectively with less dataset while fostering enhanced segmentation accuracy. Its encoder and decoder architecture is optimized for efficient execution on contemporary graphics processing units (Gpus). The fundamental purpose of U-Net architecture is to augment a conventional contracting network through a series of successive layers. These layers uplift the output resolution by employing upsampling operations.



**DenseNet**

DenseNet is a convolutional deep learning model renowned for its compactness and superior performance. DenseNet fosters dense connectivity between layers, enabling each layer to directly access gradients from all preceding layers. This intricate interconnection scheme enhances feature propagation and facilitates deeper networks without the vanishing gradient problem. This results in unparalleled parameter efficiency, improved gradient flow, and heightened feature reuse, leading to state-of-the-art results across various tasks while requiring fewer parameters. In essence, DenseNet embodies a paradigm shift in deep learning, offering remarkable efficiency and efficacy in model training and inference**.**

**CoatNET**

CoAtNet is a groundbreaking deep learning model designed to excel in handling both spatial and temporal information with remarkable efficiency. Unlike conventional architectures, CoAtNet integrates cross-attention mechanisms to dynamically focus on relevant spatial and temporal features, optimizing performance across diverse tasks such as action recognition and video understanding. This innovative approach enhances feature interaction and adaptability, enabling CoAtNet to achieve state-of-the-art results while maintaining computational efficiency. With its unique blend of spatial and temporal attention mechanisms, CoAtNet represents a significant advancement in deep learning, empowering models to effectively process complex spatiotemporal data with unprecedented accuracy and speed

**AlexNet**

AlexNet is a deep learning model that revolutionized the field of computer vision. Its groundbreaking architecture featured several key innovations, including the use of convolutional layers, ReLU activation functions, and overlapping pooling layers. These elements collectively enabled AlexNet to extract intricate features from images with unprecedented accuracy and efficiency. Moreover, its utilization of GPU acceleration paved the way for accelerated training times, setting a new standard for deep learning scalability. AlexNet's success not only solidified the prominence of convolutional neural networks in computer vision but also sparked a new era of innovation in deep learning research and application

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**VGG19**

Deep learning model comprising 19 layers, including 16 convolutional layers and 3 fully connected layers. VGG-19 achieves exceptional accuracy by systematically extracting features through stacked convolutional operations. Despite its straightforward design and simplistic layout this project has set a gold standard in the field, serving as a benchmark for subsequent models and inspiring countless innovations in deep learning research and excels in its ability to systematically extract intricate features from images, contributing to its unparalleled accuracy and reliabilityTop of Form

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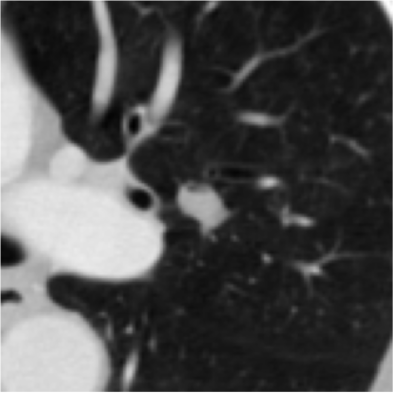
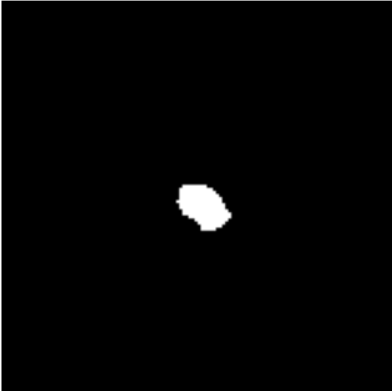
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**DATASET DESCRIPTION**

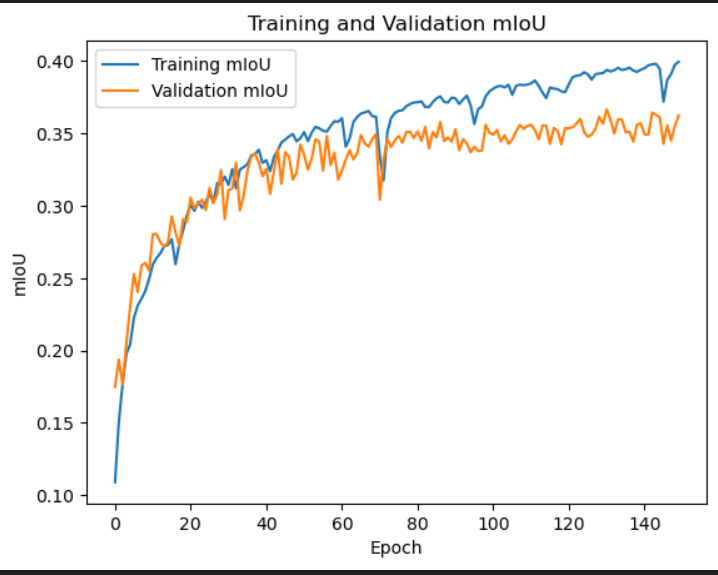
The LIDC-IDRI dataset contains lesion annotations from four experienced thoracic radiologists. LIDC-IDRI contains 1,018 low-dose lung CT’s from 1010 lung patients. Each of the cases include images from a clinical thoracic CT scan and an associated XML file that records the results of a two-phase image annotation process performed by four experienced thoracic radiologists

1. U-Net

Following 150 epochs of training, the model achieved a notable 92.17 accuracy rate and demonstrated an impressive Intersection over Union (IoU) score of 40.17 affirming its robustness in accurate data classification and object delineation.

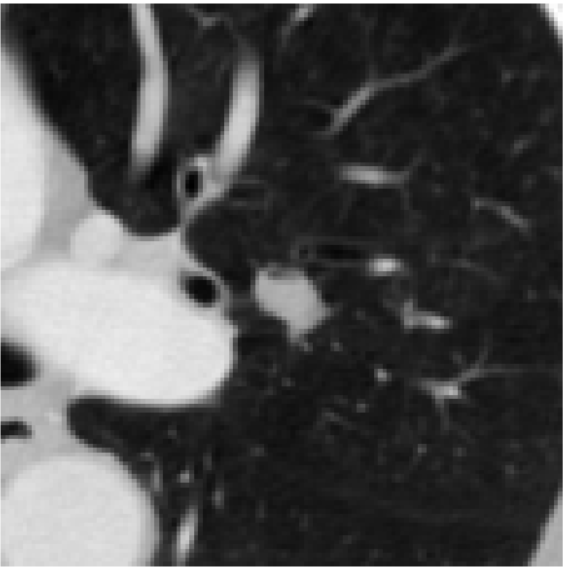
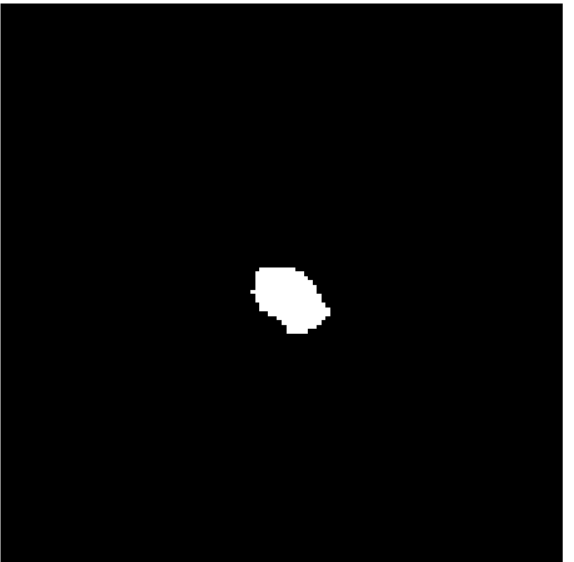
Input image segmented image



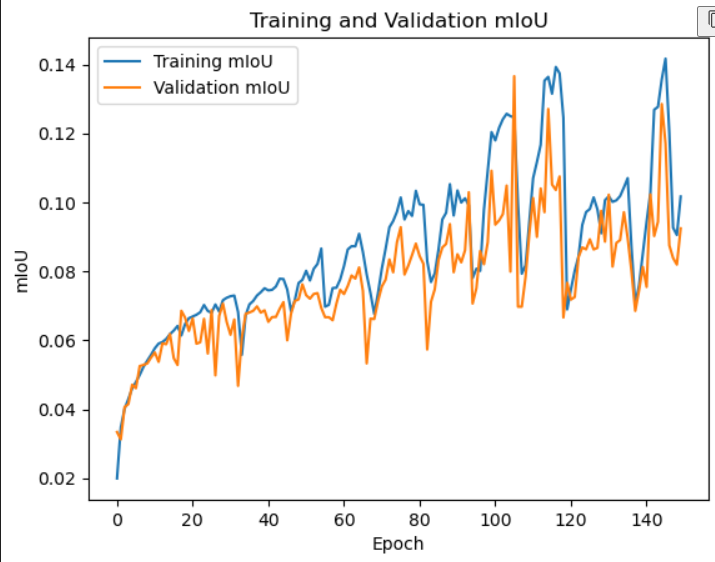
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1. Alexnet

Following 150 epochs of training, AlexNet exhibited non-convergence, evidenced by sustained loss stagnation. Despite optimization efforts, the mean Intersection over Union (mIoU) remained below 70.26, indicating suboptimal performance.

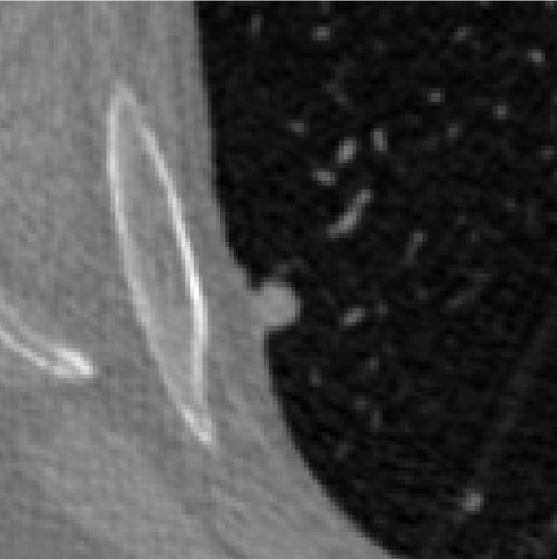
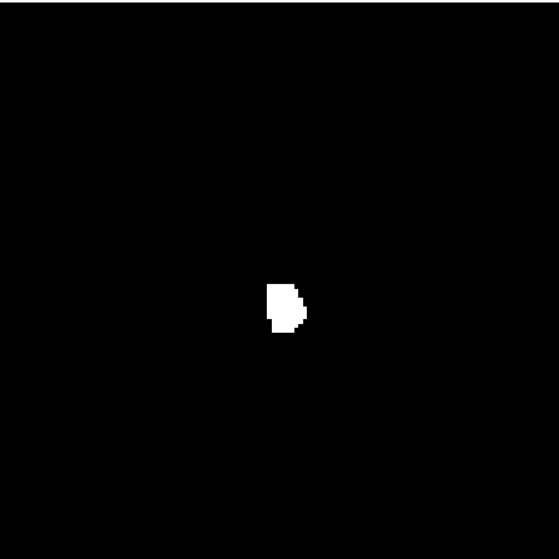
Input images segmented image



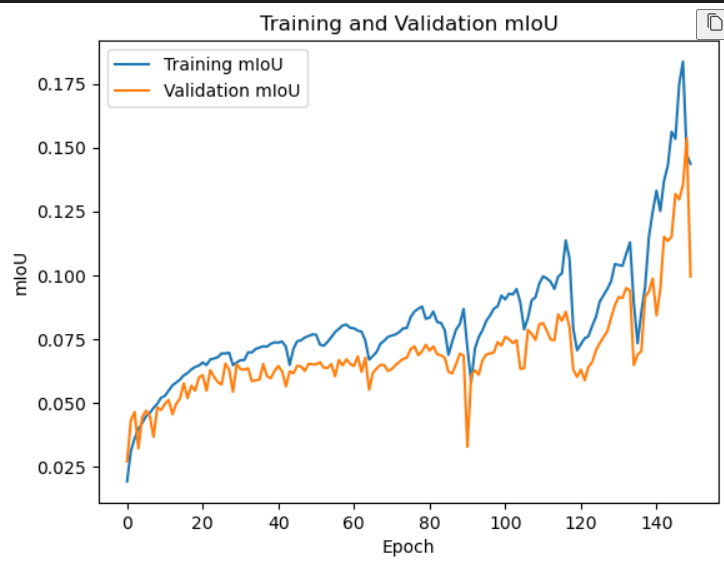
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1. DenseNet

Post ­­­epochs, the model achieved 67.56 accuracy and a 40.52 IoU accuracy, reflecting its robust performance in classification and object delineation tasks.

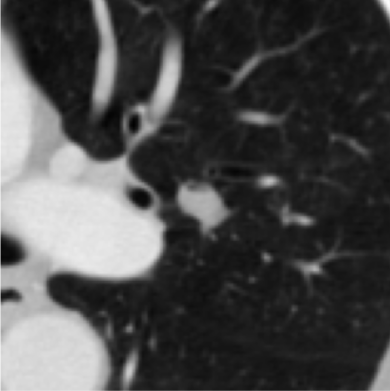
Input images segmented images



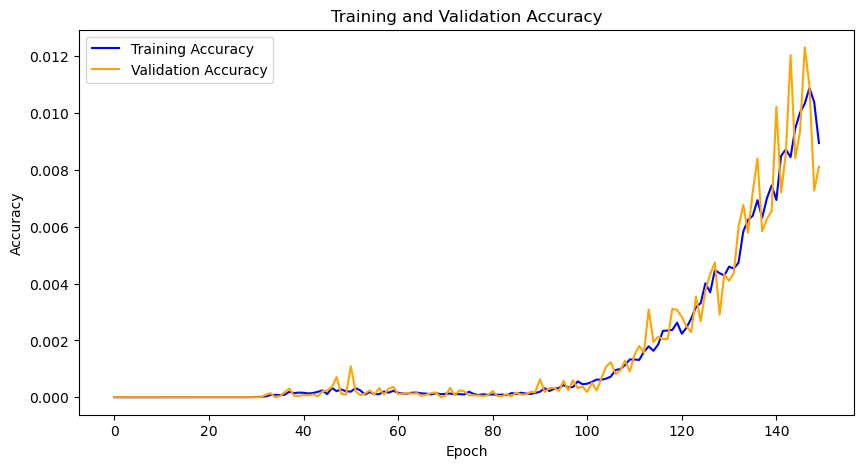
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1. CoatNet

Following 150 epochs of training, the optimization process failed to converge, leading to stagnation in the loss function. Despite iterative refinement, the Intersection over Union (IoU) metric, coupled with accuracy 40.67, exhibited negligible improvement, with IoU 15.35.

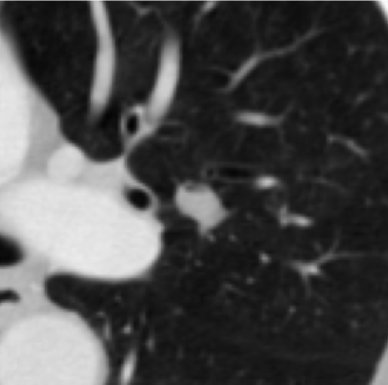
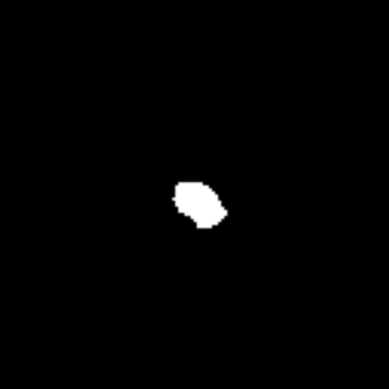
Input images segemented images



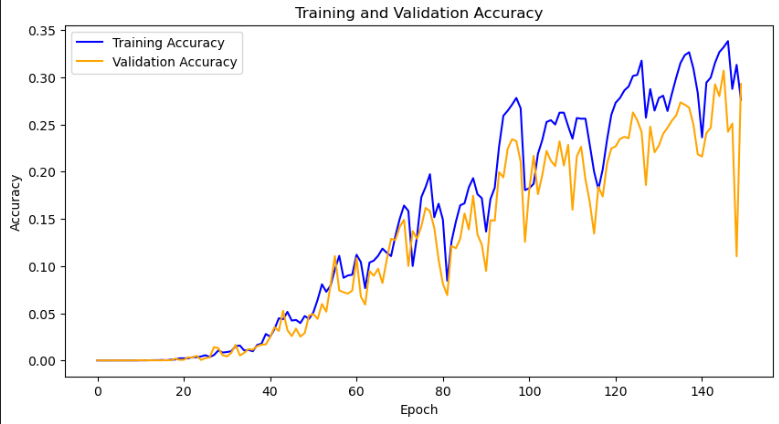
M\_iou of coatnet

1. VGG 19

Following 150 epochs of rigorous training, VGG-19 showcased notable convergence, with loss consistently decreasing. Encouragingly, both the Intersection over Union (IoU) 30.17 and accuracy surpassed 25.52, highlighting significant progress in model performance.

Input images segmented images



M\_iou of vgg19

Comparision of u-net,alexnet,coatnet,vgg19,densenet

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **METRICS** | **U-NET** | **ALEXNET** | **COATNET** | **VGG19** | **DENSENET** |
| **ACCURACY** | 92.17 | 89.83 | 40.67 | 25.52 | 67.56 |
| **MCC** | 92.36 | 49.87 | 58.42 | 18.32 | 89.02 |
| **AUC** | 98.81 | 98.85 | 94.46 | 97.31 | 98.83 |
| **MEAN\_IOU** | 40.17 | 70.26 | 15.35 | 30.17 | 40.52 |

**CONCLUSION**

The investigation revealed U-Net's superior performance when applied to the LIDC-IDRI dataset, surpassing CoatNet which struggled to converge effectively. Challenges arose from the dataset's size, leading to interpretability issues and data constraints. Consequently, the study endeavors to mitigate these challenges by leveraging region of interest (ROI) considerations within the models. While significant progress has been made, further research is warranted to enhance CoatNet's efficacy for segmentation tasks, thereby advancing the field's capabilities.

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