# DAYANANDA SAGAR UNIVERSITY

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING
SCHOOL OF ENGINEERING
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KUDLU GATE
BANGALORE - 560068

**PROJECT REPORT**

***ON***

# "Kidney Segmentation:A Model That Can Segment The Kidneys From CT Or MRI Images "

Data Science (20CS3620)

6 th SEMESTER

BACHELOR OF TECHNOLOGY

IN

COMPUTER SCIENCE & ENGINEERING

***Submitted by***

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## CERTIFICATE

***This is to certify that Ms SHAREEBA N bearing USN ENG20CS0332 has satisfactorily completed his Mini Project as prescribed by the University for the SIXTH semester B.Tech programme in Computer Science & Engineering during the year 2022-2023 at the School of Engineering, Dayananda Sagar University., Bangalore.***

Date: ______________

Signature of the faculty in-charge

| Max Marks | Marks Obtained |
|---|---|
| | |

_________________

Signature of Chairman

Department of Computer Science & Engineering

## DECLARATION

I hereby declare that the work presented in this project entitled -**Kidney Segmentation:A Model That Can Segment The Kidneys From CT Or MRI Images**, has been carried out by me and it has not been submitted for the award of any degree, diploma or the project of any other college or university.

Shareeba N– (ENG20CS0332)

## ACKNOWLEDGEMENT

The satisfaction that accompanies the successful completion of a task would be incomplete without the mention of the people who made it possible and whose constant guidance and encouragement crown all the efforts with success.

I am very much thankful to our **teacher Dr Pramod Naik**, for providing help and suggestions in completion of this project successfully.

I have received a great deal of guidance.I wish to thank all that have directly or indirectly helped me in the successful completion of this project work.

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# ABSTRACT

Kidney diseases are one of the most common diseases worldwide and cause unbearable pain in most people. In this study aims to detecting the cyst and stone in the kidney. For the this purpose, YOLO architecture designs were used for detection of kidney, kidney cyst and kidney stone. The YOLO architecture designs were supported by the explainable artificial intelligence (xAI) feature. As a result, YOLOv5 architecture design outperformed the YOLOv3 Tiny architecture design. YOLOv5 architecture design achieved the mAP50 of 0.85, precision of 0.882, sensitivity of 0.829 and F1 score of 0.854. Consequently, deep learning based xAI assisted computer aided diagnosis (CAD) system was developed for diagnosis of kidney diseases.
**Keywords: Kidney stone, Kidney cyst, Deep learning, YOLOv7, Explainable artificial intelligence.**

# INTRODUCTION

Kidney pain is one of the most common complaints, although the rate of complaints in emergency and clinical presentations varies. In prevalence studies (Türk et al., 2016; Stamatelou et al., 2003), it is seen that this rate reaches up to 20% and is increasing gradually. The incidence of kidney stones in people aged 20 to 74 living in the United States (US) is approximately 9% (Scales et al., 2012). The probability of coming to the emergency department with the complaint of kidney stones is critical. This number is seen to reach 1,000,000 every year in the US, additionally this number has doubled between 1992 and 2009 (Fwu et al., 2013). At the same time, the incidence of this disease was higher between 1988 and 1994 than between 1976 and 1980. It has been observed that this rate gradually increased between 2007 and 2016 (Chewcharat & Curhan, 2021).

Nowadays, artificial intelligence (AI) is intended to be primarily used in the field of medicine. Several researches have been carried out in various fields by using images in the medical field together with the deep learning and machine learning techniques. These techniques have been successfully used in segmentation of medical images (Weston et al., 2019), classification of diseases (Ozturk et al., 2020), lesion detection (Yan et al., 2018) and in many other fields. Medical products and services are products that must be of high reliability. To fully trust these products, knowing why artificial intelligence makes its decisions is the most important step. While providing a high level of learning performance with explainable AI (xAI), it also explains why the decision was made. In this way, the reason for the decision can be questioned and its correctness can be discussed in a better way. Recently, AI based studies have been performed in many areas such as the treatment process of diseases in the human body (Z. Lin et al., 2021). The main purpose of AI assisted diagnosis is to develop systems that enable radiologists to assist in the detection of disease. Examples of these systems are kidney segmentation (D. T. Lin et al., 2006), cyst segmentation (Z. Lin et al., 2021).

Choosing an accurate imaging method for the detection of kidney stones and cysts is of vital importance as it is the first step of treatment. Non-contrast computed tomography (CT) of the abdomen provides the most accurate diagnosis, but exposes the patient to radiation. Ultrasonography, on the other hand, has lower sensitivity than CT, but its advantage is that no radiation is used in its use. In MR imaging method, it uses the 3D imaging method, but this method is both costly and difficult to evaluate kidney stones (Weston et al., 2019). Therefore, computer aided diagnosis (CAD) has been developed to find kidney stones and cysts to give advice to radiologists. Correctly determining the location of the kidney stone and cyst is an important preliminary step. Thanks to the correct determination to be made, it will provide quantitative information to pay attention to the stones that will be missed. These systems, which automatically detect them and show their locations, provide great convenience to radiologists.

# PROBLEM STATEMENT

Unfortunately in Kidney Tumour, knowing where cancer is present in a precise manner is very difficult, it leads to potentially dangerous situations for patients too. Professional medical imaging still requires expert human interpretation for cancer detection in the kidney. This leads to very subjective, highly variable renderings. Detection of such a severe disease is very important for all human beings because of its adverse effect, also the treatment is too costly. Doctors are able to diagnose it when a patient approaches them, but it will be better if the disease can be predicted much more in advance. Patients will be benefited if the detection can be done at an early stage that will help in early treatment.

To build a Model for Tumour segmentation in Kidney that will help medical experts to have a support system that can automatically and accurately segment tumours in the kidney, if a kidney is having malignant cell presence.

# SOFTWARE AND HARDWARE REQUIREMENTS

## SOFTWARE:

- Windows 10 and above
- Python 3.0 onwards
- Tensorboard
- Numpy package
- Pandas package
- Roboflow
- YOLOv5
- Pytorch
- Glob package
- Google colab

## HARDWARE:

2.60 GHz CPU, 4GB RAM , 1024x768 display,5400 RPM hard disk

# PROPOSED METHODOLOGY

## YOLOv5:

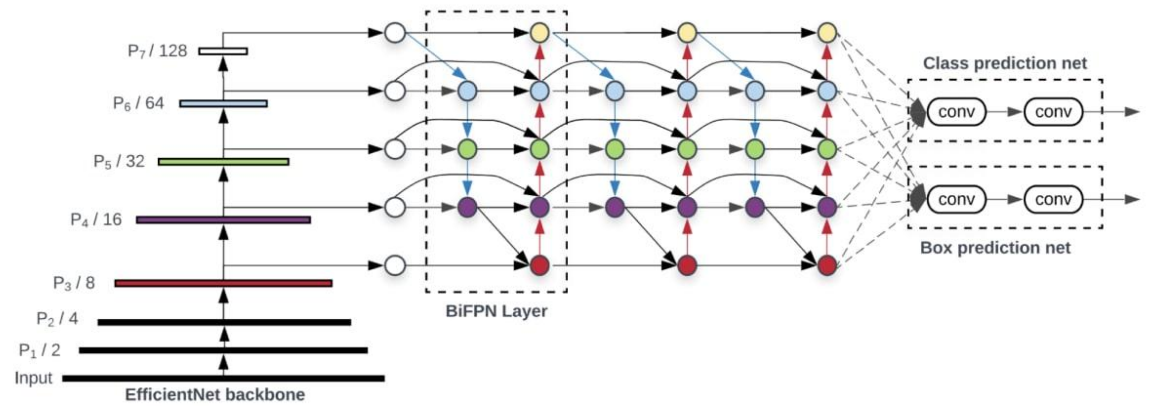
You Only Look Once (YOLO) proposes using an end-to-end neural network that makes predictions of bounding boxes and class probabilities all at once. It differs from the approach taken by previous object detection algorithms, which repurposed classifiers to perform detection.

Following a fundamentally different approach to object detection, YOLO achieved state-of-the-art results, beating other real-time object detection algorithms by a large margin.

While algorithms like Faster RCNN work by detecting possible regions of interest using the Region Proposal Network and then performing recognition on those regions separately, YOLO performs all of its predictions with the help of a single fully connected layer.

YOLOv5 was introduced in 2020 by the same team that developed the original YOLO algorithm as an open-source project and is maintained by Ultralytics. YOLO v5 builds upon the success of previous versions and adds several new features and improvements.

Unlike YOLO, YOLO v5 uses a more complex architecture called EfficientDet (architecture shown below), based on the EfficientNet network architecture. Using a more complex architecture in YOLO v5 allows it to achieve higher accuracy and better generalisation to a wider range of object categories.




**EfficientDet architecture** – It employs EfficientNet [39] as the backbone network, BiFPN as the feature network, and shared class/box prediction network. Both BiFPN layers and class/box net layers are repeated multiple times based on different resource constraints as shown in Table 1.

Another difference between YOLO and YOLO v5 is the training data used to learn the object detection model. YOLO was trained on the PASCAL VOC dataset, which consists of 20 object categories. YOLO v5, on the other hand, was trained on a larger and more diverse dataset called D5, which includes a total of 600 object categories.

YOLO v5 uses a new method for generating the anchor boxes, called "dynamic anchor boxes." It involves using a clustering algorithm to group the ground truth bounding boxes into clusters and then using the centroids of the clusters as the anchor boxes. This allows the anchor boxes to be more closely aligned with the detected objects' size and shape.

YOLO v5 also introduces the concept of "spatial pyramid pooling" (SPP), a type of pooling layer used to reduce the spatial resolution of the feature maps. SPP is used to improve the detection performance on small objects, as it allows the model to see the objects at multiple scales. YOLO v4 also uses SPP, but YOLO v5 includes several improvements to the SPP architecture that allow it to achieve better results.

# DATA ANALYSIS

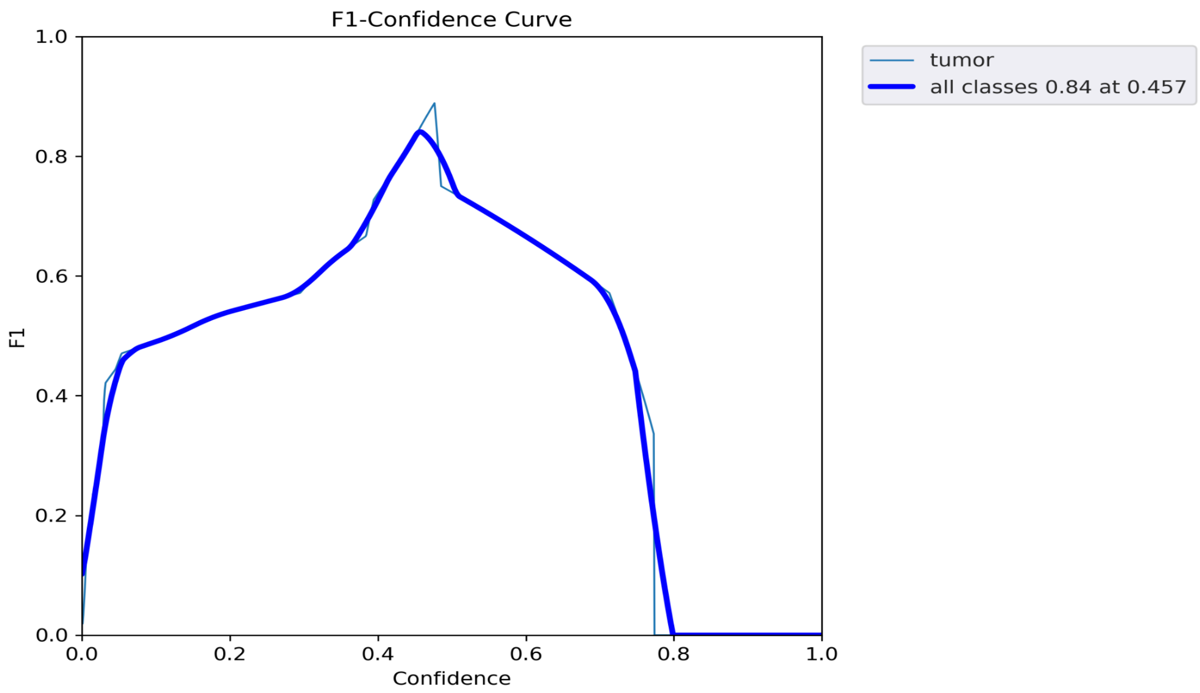
## DATASET DESCRIPTION AND PRE-PROCESSING

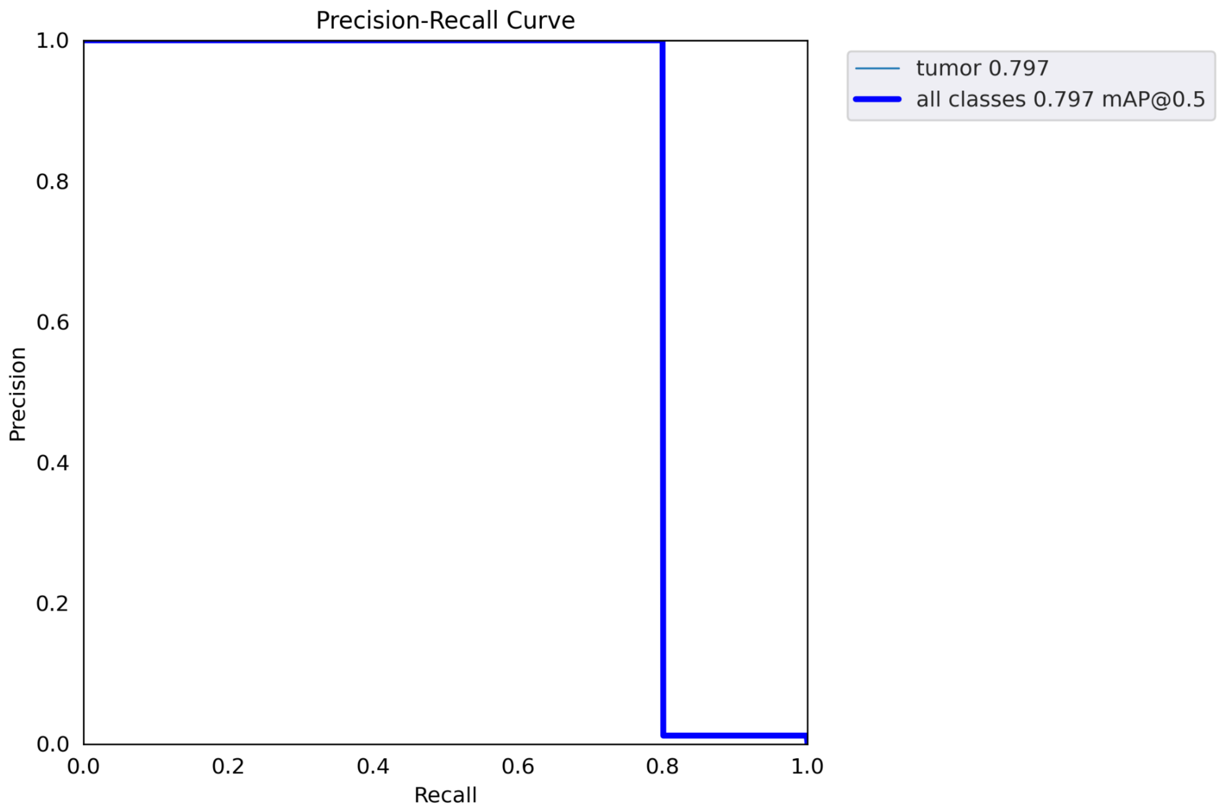
The dataset for this project have been taken from : Kidneyone.v3-kidney-datset.yolov5pytorch

```
os.environ["DATASET_DIRECTORY"]="/contents/datasets"
pip install roboflow

from roboflow import Roboflow
rf = Roboflow(api_key="S3pltpKOukkRzbXF9gUV")
project = rf.workspace("kidney-emjeg").project("kidneyone")
dataset = project.version(3).download("yolov5")
```

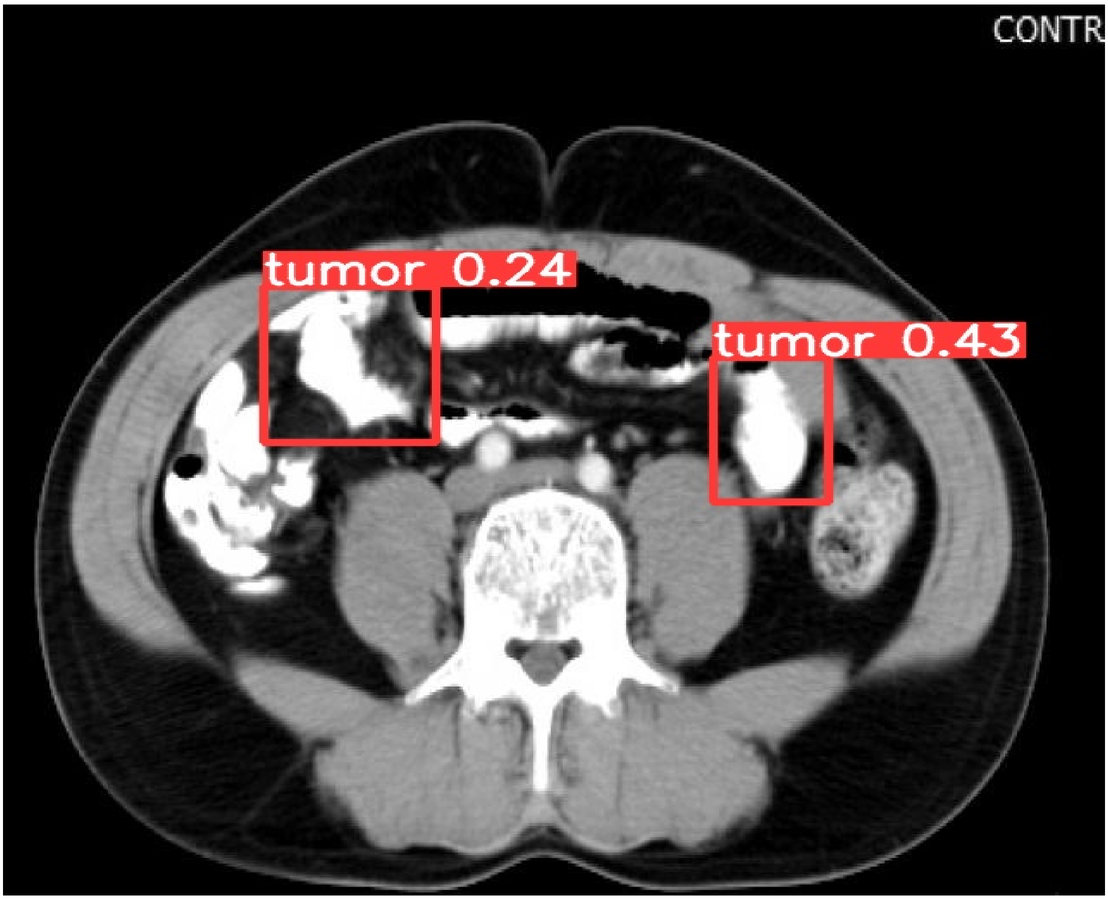
## 4.2 TRAINING AND TESTING THE MODEL

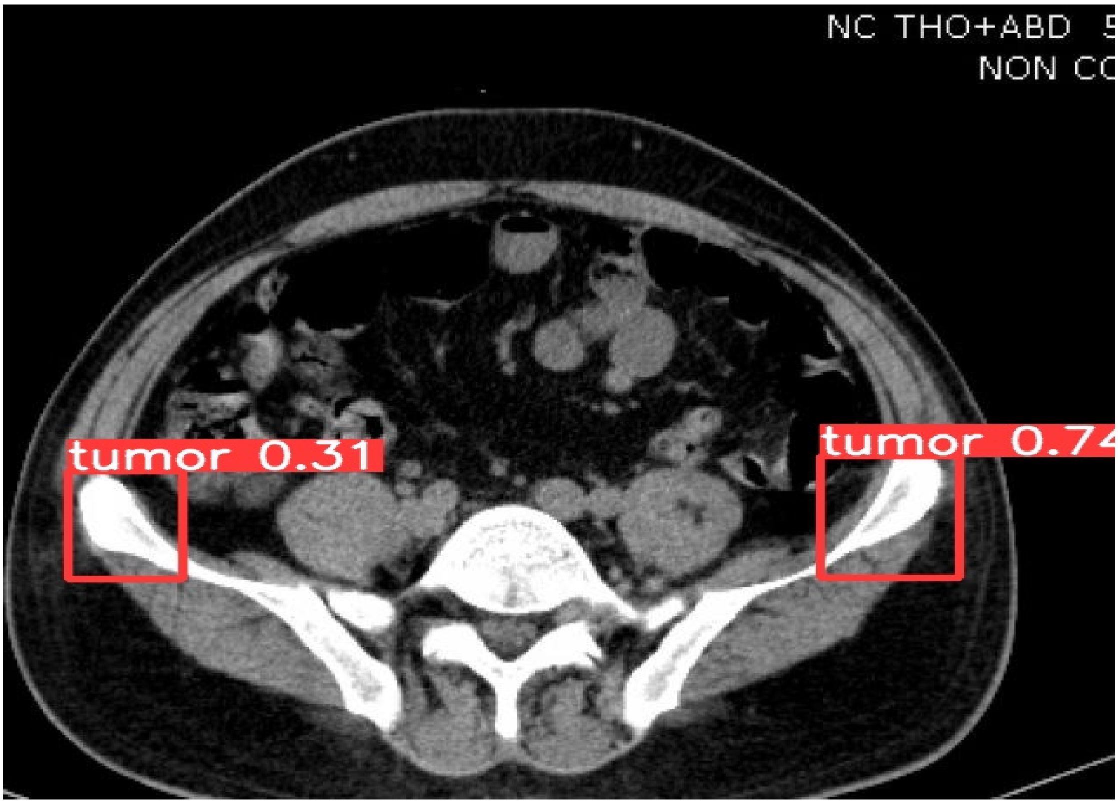
```
python train.py --img 416 --epochs 100 --data {dataset.location}/data.yaml --weights /content/yolov5s.pt --batch-size 16

%load_ext tensorboard
%tensorboard --logdir runs
```




Precision-Recall Curve
Precision
Recall
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0
tumor 0.797
all classes 0.797 mAP@0.5

# SNAPSHOTS


CONTR
tumor 0.24
tumor 0.43


NC THO+ABD 5
NON CO
tumor 0.31
tumor 0.74

# Conclusion

In conclusion, in our project we developed a cascaded segmentation network for medical images to realise tumour region segmentation in kidney CT data. Because tumours are irregularly shaped and relatively small in volume compared to the kidney and may appear at different locations in the kidney, we first used a target detection algorithm based on the YOLO-V5 m implementation to quickly localise tumour regions in the raw kidney CT data. Next, we applied it to localised regions to perform the final accurate segmentation of the tumour. the proposed model is more accurate and robust than existing methods. the proposed cascaded segmentation network greatly improves the efficiency of medical image segmentation. Finally, ablation experiments demonstrated that the proposed network yields superior medical image segmentation performance.

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