KIDNEY DISEASE DETECTION

Using Transfer Learning Techniques

Team Data Wranglars

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01 PROBLEM STATEMENT

This research project aims to create a model that can accurately detect whether a kidney image has a disease and classify the disease as severe or not. By training the model on a large dataset of kidney images, we hope to create a tool that can assist medical professionals in diagnosing kidney diseases quickly and accurately. The project uses state-of-the-art machine learning techniques to improve patient outcomes and reduce the burden on healthcare systems by enabling earlier and more accurate diagnosis of kidney diseases.

02 DATASET

Data Collection

The dataset was collected from PACS (Picture archiving and communication system) from different hospitals in Dhaka, Bangladesh where patients were already diagnosed with having a kidney tumor, cyst, normal or stone findings.

Pre-Processing and Augmentation

The images were resized to (224x250 px) and batch normalization was performed along with Data Augmentation to prevent overfitting and get faster training time

Splitting the Data

The dataset was split into the train (80%), test (10%), and val (10%) datasets for easy usage.

03 TOOLS USED

The Model was made using various Python libraries such as NumPy, Pandas, Matplotlib, Seaborn, Scikit-learn and TensorFlow and was deployed using Gradio

NumPy

Pandas

Matplotlib

seaborn

scikit learn

Tensorflow

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APPROACH AND OUTCOME

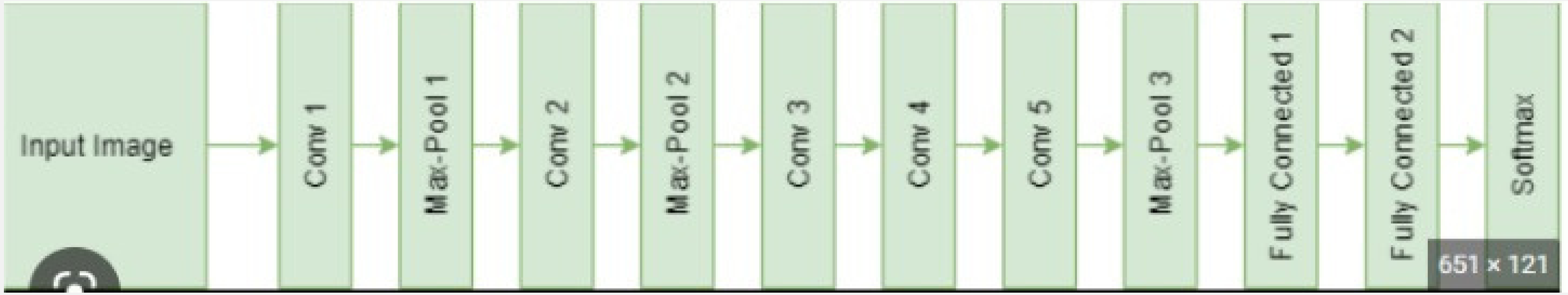
FACTORS CONSIDERED WHILE CHOOSING THE MODEL

- Type of Dataset
- Model Compelxity
- Predictive Power
- Cost
- Time Efficiency

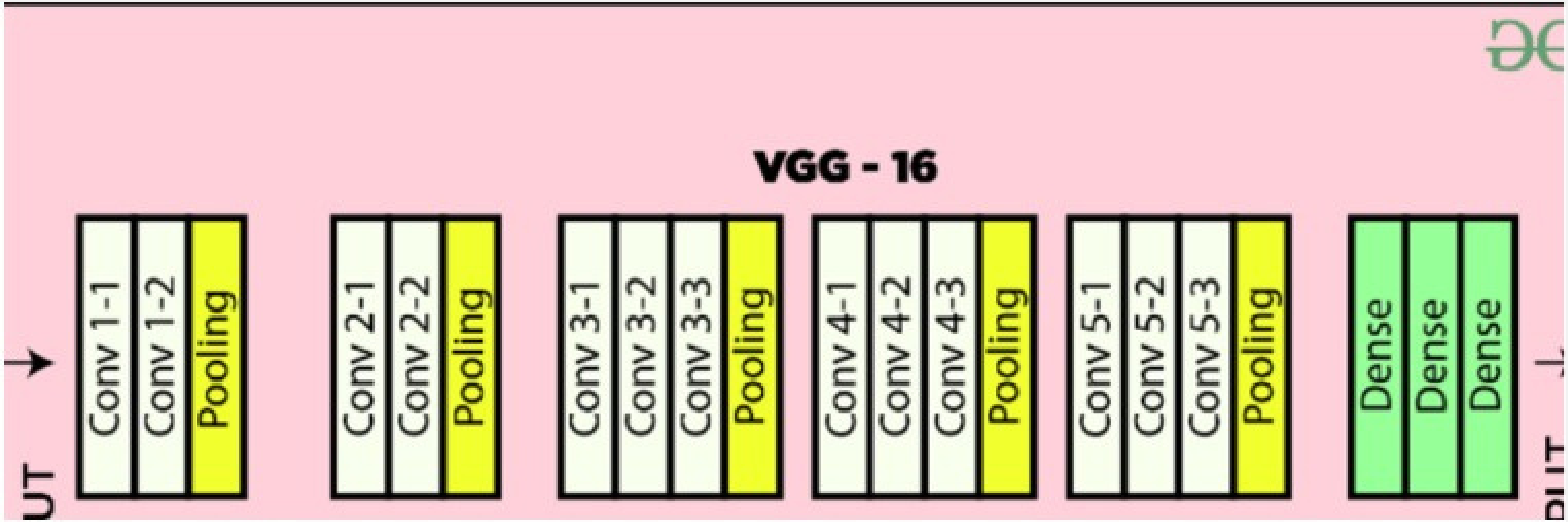
EFFICIENT-NET B3

Stage i	Operator $\hat{\mathcal{F}}_i$	Resolution $\hat{H}_i \times \hat{W}_i$	#Channels $\hat{C}_i$	#Layers $\hat{L}_i$
1	Conv3x3	224×224	32	1
2	MBConv1, k3x3	112×112	16	1
3	MBConv6, k3x3	112×112	24	2
4	MBConv6, k5x5	56×56	40	2
5	MBConv6, k3x3	28×28	80	3
6	MBConv6, k5x5	14×14	112	3
7	MBConv6, k5x5	14×14	192	4
8	MBConv6, k3x3	7×7	320	1
9	Conv1x1 & Pooling & FC	7×7	1280	1

ALEX-NET


Input Image
Conv 1
Max-Pool 1
Conv 2
Max-Pool 2
Conv 3
Conv 4
Conv 5
Max-Pool 3
Fully Connected 1
Fully Connected 2
Softmax
651 × 121

VGG-16



VGG - 16
Conv 1-1
Conv 1-2
Pooling
Conv 2-1
Conv 2-2
Pooling
Conv 3-1
Conv 3-2
Conv 3-3
Pooling
Conv 4-1
Conv 4-2
Conv 4-3
Pooling
Conv 5-1
Conv 5-2
Conv 5-3
Pooling
Dense
Dense
Dense

CLASSIFICATION REPORT

Classification Report:
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	precision	recall	f1-score	support
Cyst	0.9946	0.9928	0.9937	556
Normal	0.9987	0.9948	0.9967	762
Stone	0.9810	0.9952	0.9880	207
Tumor	0.9942	0.9971	0.9956	342
accuracy			0.9946	1867
macro avg	0.9921	0.9950	0.9935	1867
weighted avg	0.9947	0.9946	0.9947	1867

Accuracy: 0.8262610088070457

Precision: 0.8950967554197584

Recall: 0.7648047745590447

F1_score: 0.7971625228913921

Classes	Precision	Recall	F1-Scor
0	0.99	0.94	0.97
1	0.49	0.87	0.63
2	0.86	0.95	0.90
3	0.30	0.91	0.45

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EXPLORING THE DETECTION MODEL

The Transfer Learning technique was used to fine-tune the EfficientNet 3 model. The model was enhanced by adding a batch normalization layer, a dense layer with 256 neurons, a dropout layer, and a final output dense layer with the number of neurons equal to the number of classes. Techniques like Resolution Scaling and Width Scaling were used to further improve the model.

Classification Report:

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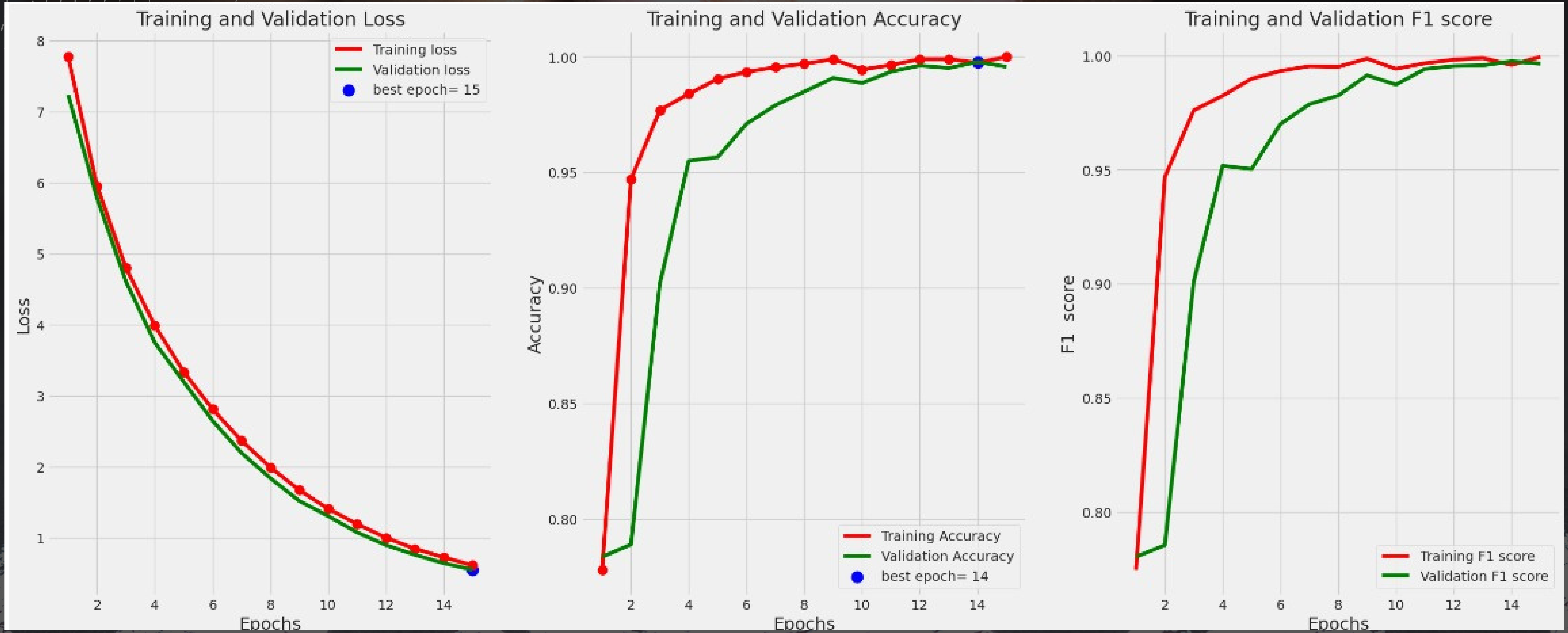
	precision	recall	f1-score	support
Cyst	0.9964	0.9856	0.9910	556
Normal	1.0000	0.9987	0.9993	762
Stone	0.9626	0.9952	0.9786	207
Tumor	1.0000	1.0000	1.0000	342
accuracy			0.9946	1867
macro avg	0.9897	0.9949	0.9922	1867
weighted avg	0.9948	0.9946	0.9947	1867


Training and Validation Loss
Training loss
Validation loss
best epoch= 15
Loss
Epochs
Training and Validation Accuracy
Training Accuracy
Validation Accuracy
best epoch= 14
Accuracy
Epochs
Training and Validation F1 score
Training F1 score
Validation F1 score
F1 score
Epochs

06 FUTURE POTENTIAL & CONCLUSION

- Kidney stones affect approximately **1 in 11 people worldwide**, and the number of cases is **increasing every year**. Delayed diagnosis and treatment of kidney stones can lead to **serious complications**, including kidney damage, infection, and sepsis.
- With the **increasing prevalence of kidney stones**, the need for a **predictive tool** that can **accurately diagnose** and assess the severity of the condition is critical.
- The Future Versions of this application will be able to provide **actionable advice to medical professionals** and would be able to **track and monitor the patient's health** over time, as well as provide detailed information about the patient's medical history and current treatment plan.
- With the help of this application, medical professionals can better manage the patients and provide **timely treatment**. Additionally, this application can also be used to **educate patients** about the **risks and causes of kidney stones**, as well as provide them with **preventative measures** to reduce the risk.

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