TUBERCULOSIS DETECTION

using Chest X-ray

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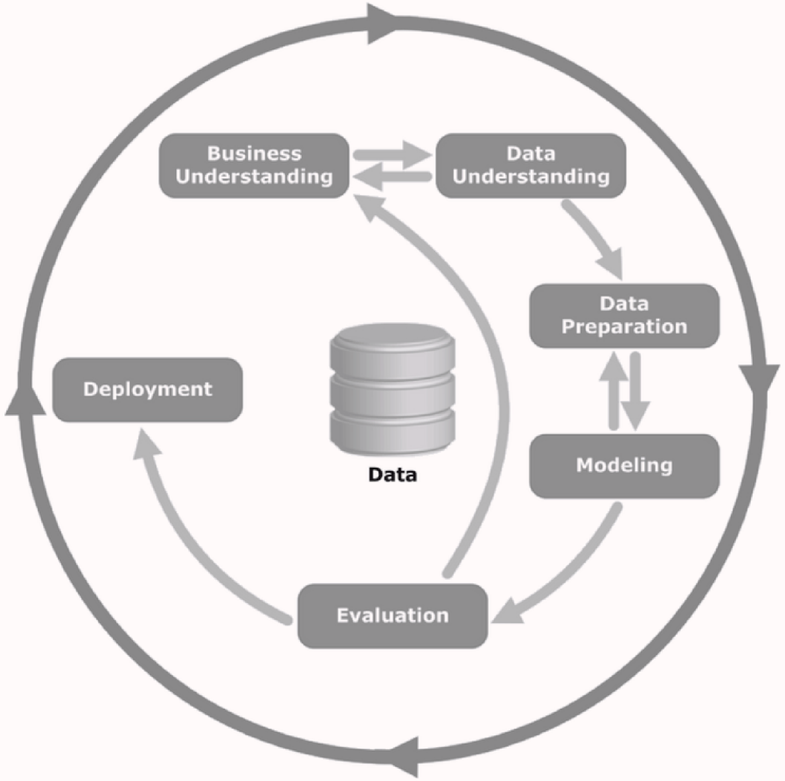
METHODOLOGY

CRISP-DM

(Cross-Industry Standard Process for Data Mining)



BUSINESS UNDERSTANDING

BUSINESS TYPE

Healthcare, Medical

PROBLEM?

Hard diagnose

Tuberculosis can present with a wide range of symptoms such as Pneumonia, Lung Cancer, Bronchitis, etc. making it difficult to accurately diagnose.

Key facts

Tuberculosis (TB) remains a global health challenge, with 1.6 million TB-related deaths in 2021. It is the **second** leading infectious killer worldwide, following COVID-19.

GOAL

Develop an accurate and efficient deep learning model for the automated detection and classification of Tuberculosis (TB) in chest X-ray images. The goal is to assist healthcare, thereby **improving patient outcomes** and **reducing the spread of the disease.**

DATA UNDERSTANDING

01

DATA

- **Amount**: 700 Tuberculosis images / 3500 normal images.
- **File type**: PNG
- **Image size**: 512x512
- **Channel**: 3 channel (RGB)
- **Target**: Disease = 1, No disease = 0

02

ANALYSIS

- **Contrast of X-ray Image:** Which Chest X-ray Image Processing/Enchantment gives better performances?
- **X-ray Image Input Sizes**: Exploring Different Image Input Sizes What input sizes give the best performance and avoid the need for unnecessarily larger inputs?

03

TARGET

Classes

Disease	No disease
1	0

04

DATA PREPARATION

DATA TRANSFORMING

- **Tabulating**: PNG Files to NumPy Arrays
- **Color Conversion**: RGB to Grayscale
- **Image Resizing**: 512x512 to 128x128

DATA AUGMENTATION + CLINICAL PERSPECTIVE

- Solve class Imbalance
- 700 Tuberculosis images / 3500 normal images.

VARIABLE

DATA PROCESSING

IMAGE PROCESSING/ENCHANTMENT

- Contrast Stretching
- Histogram Equalization
- Adaptive Histogram Equalization

NORMALIZATION

- Min-Max Normalization

READY TO TRAIN!

MODELING

Experimentation
Hyperparameter Tuning
Evaluation
Explainability

EXPERIMENTATION

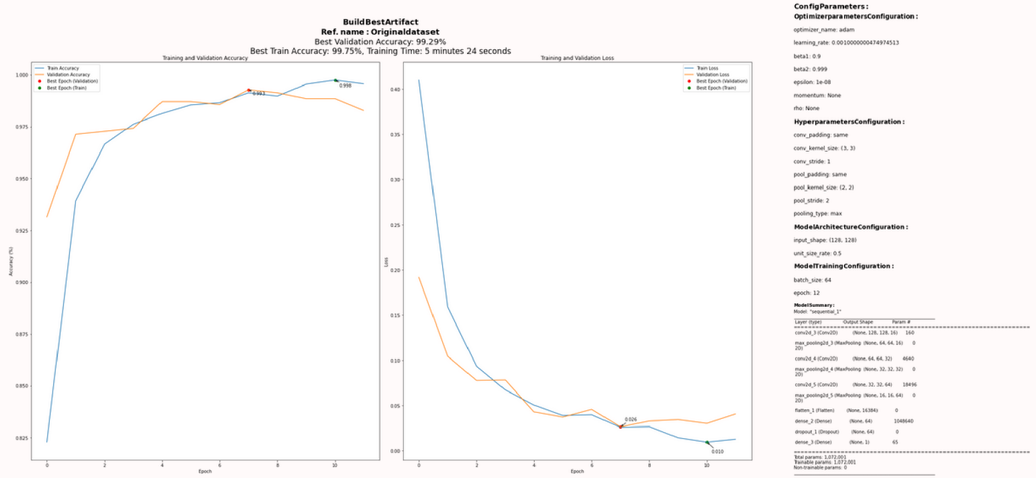
Training and Evaluation and Experiment

- **Experiment 1**: Building the First CNN Model
- **Experiment 2**: Comparing Optimizers
- **Experiment 3**: Comparing Pooling Techniques
- **Experiment 4**: Tuning Hyperparameters - Padding, Kernel Size, and Stride
- **Experiment 5**: Hyperparameter Optimization
  - **Experiment 5.1**: Learning Rate (λ) for Adam
  - **Experiment 5.2**: Epsilon (ε) for Adam
  - **Experiment 5.3**: Batch Size
  - **Experiment 5.4**: Number of Epochs
- **Experiment 6**: Image Enhancement Techniques
- **Experiment 7**: Impact of Varying Unit Sizes in Neural Network Layers
- **Experiment 8:** Exploring Different Image Input Sizes

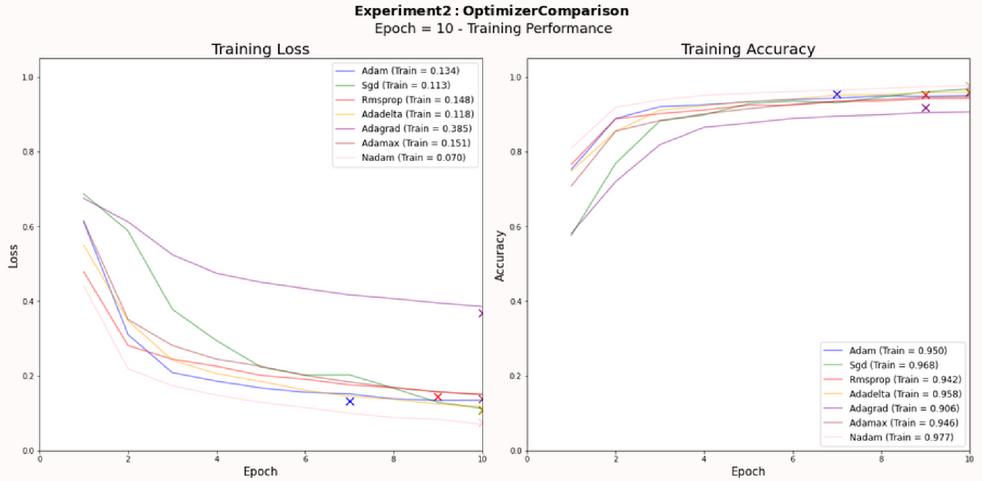
EXPERIMENTATION

Training and Evaluation and Experiment

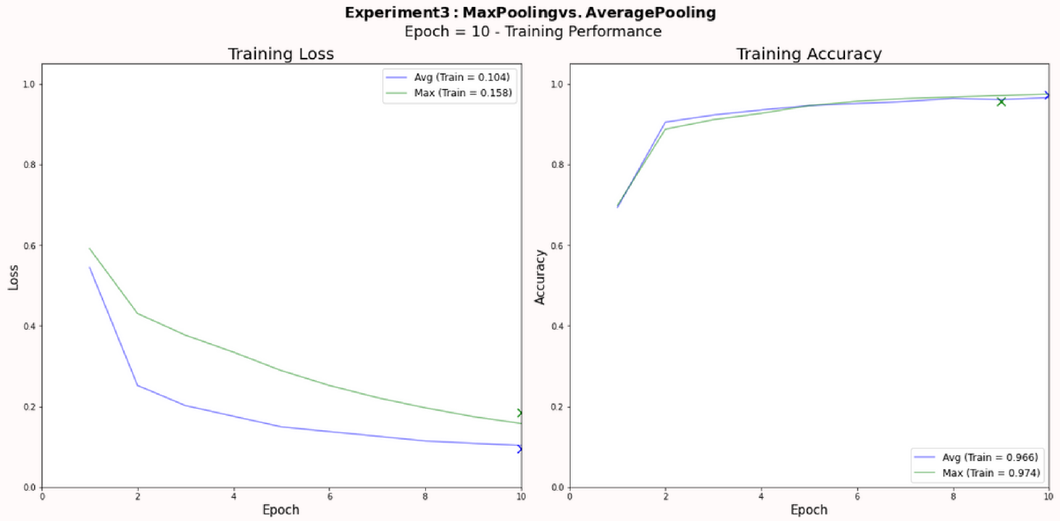
- **Experiment 1**: Building the First CNN Model



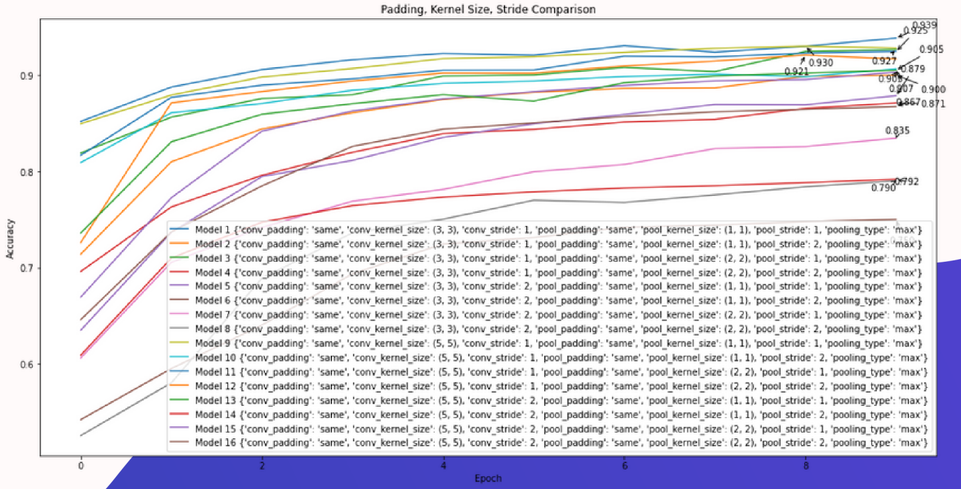
- **Experiment 2**: Comparing Optimizers



- **Experiment 3**: Comparing Pooling Techniques



- **Experiment 4**: Tuning Hyperparameters - Padding, Kernel Size, and Stride

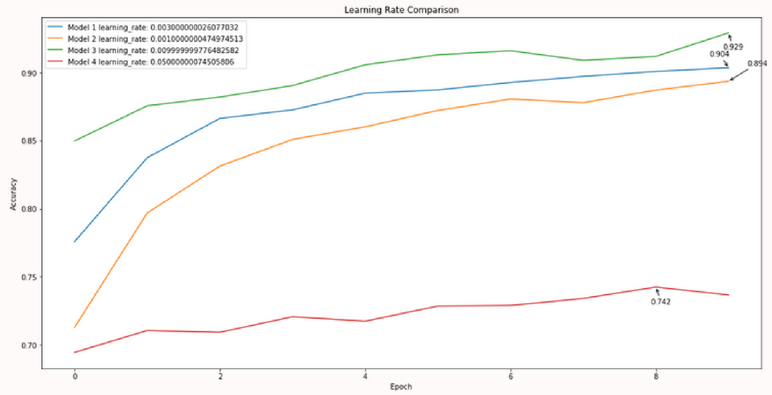


EXPERIMENTATION

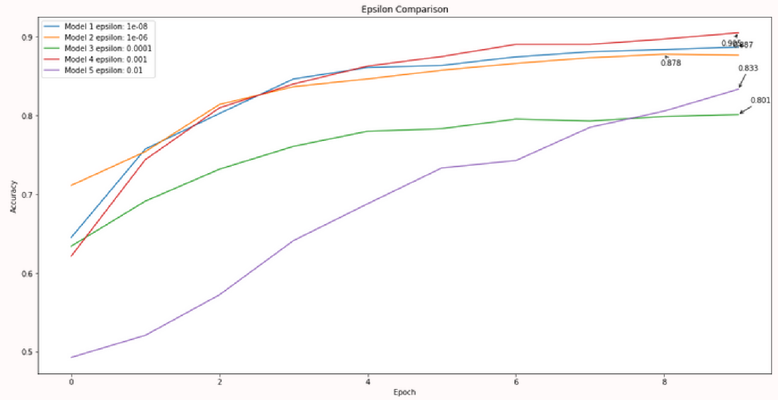
Training and Evaluation and Experiment

Experiment 5: Hyperparameter Optimization

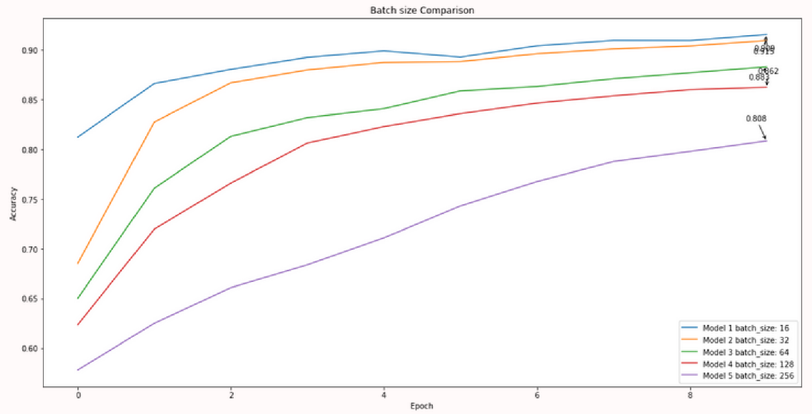
- **Experiment 5.1**: Learning Rate (λ) for Adam



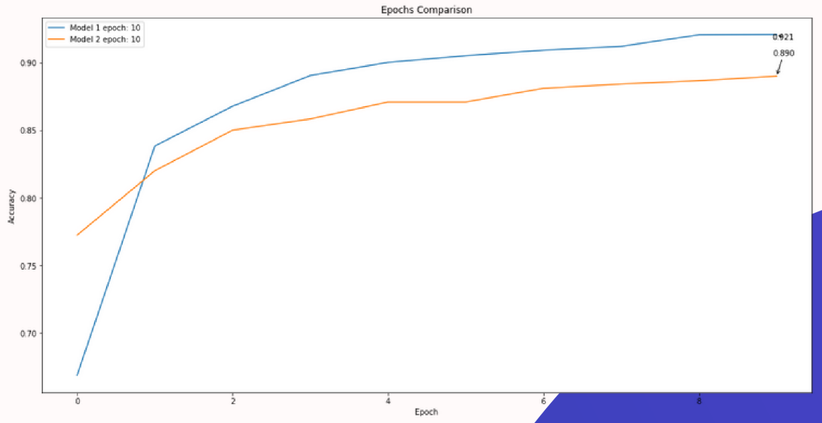
- **Experiment 5.2:** Epsilon (ε) for Adam



- **Experiment 5.3**: Batch Size



- **Experiment 5.4**: Number of Epochs



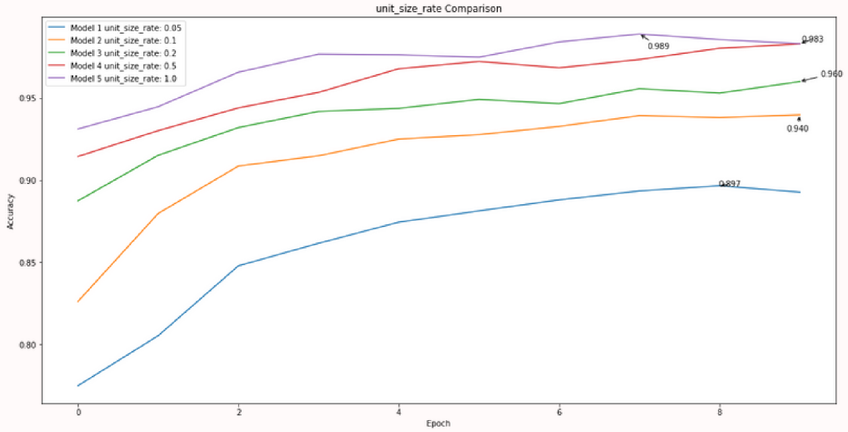
EXPERIMENTATION

Training and Evaluation and Experiment

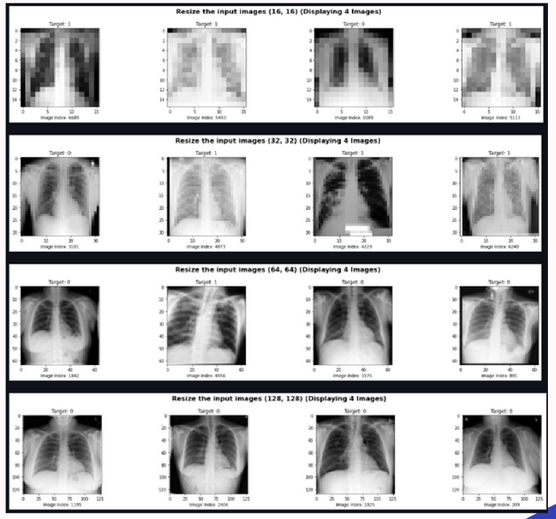
- **Experiment 6**: Image Enhancement Techniques

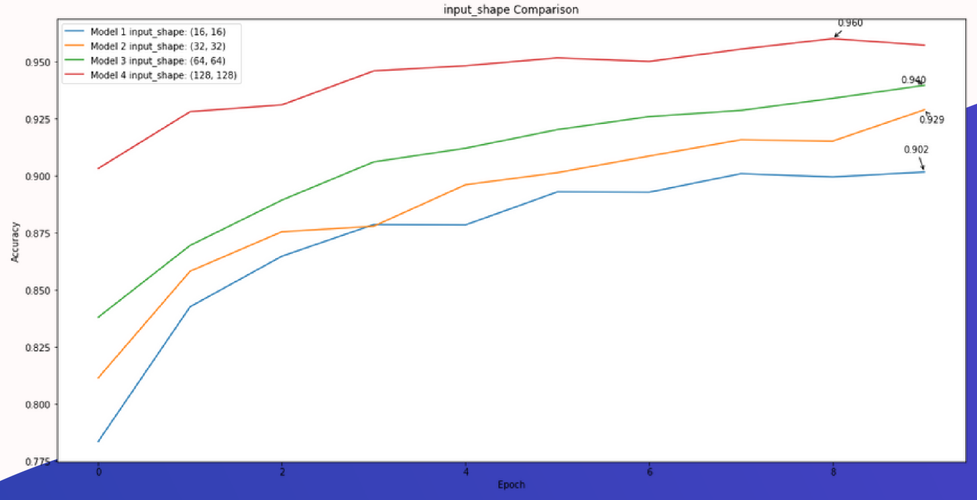
Model	Timestamp	Reference name	Optimizer parameters Configuration	Hyperparameters Configuration	Model Architecture Configuration	Model Training Configuration	accuracy_train	accuracy_val	Subset	...	Training in seconds	TP	FP	FN	TN	Precision	Recall	F1	AUC	Accuracy
CNN_Original (Normalized)	2023-09-25 16:37:42	Original dataset	{'optimizer_name': 'nadam', 'learning_rate': 0...	{'conv_padding': 'same', 'conv_kernel_size': (...	{'input_shape': (128, 128), 'unit_size_rate': ...	{'batch_size': 64, 'epoch': 10}	[0.7769643068313599, 0.9123214483261108, 0.932...	[0.8471428751945496, 0.9257143139839172, 0.917...	Test	...	91.363643	342	8	20	330	0.960541	0.960000	0.959988	0.960000	0.960000
CNN_Original (PCA)	2023-09-25 16:39:24	Original dataset	{'optimizer_name': 'nadam', 'learning_rate': 0...	{'conv_padding': 'same', 'conv_kernel_size': (...	{'input_shape': (128, 128), 'unit_size_rate': ...	{'batch_size': 64, 'epoch': 10}	[0.7421428561210632, 0.9294642806053162, 0.944...	[0.8899999856948853, 0.9428571462631226, 0.955...	Test	...	96.033478	341	9	33	317	0.942079	0.940000	0.939929	0.940000	0.940000
CNN_Contrast Stretching	2023-09-25 16:41:05	Original dataset	{'optimizer_name': 'nadam', 'learning_rate': 0...	{'conv_padding': 'same', 'conv_kernel_size': (...	{'input_shape': (128, 128), 'unit_size_rate': ...	{'batch_size': 64, 'epoch': 10}	[0.7076785564422607, 0.8553571701049805, 0.904...	[0.8199999928474426, 0.8642857074737549, 0.884...	Test	...	95.988213	335	15	19	331	0.951488	0.951429	0.951427	0.951429	0.951429
CNN_Histogram Equalization	2023-09-25 16:42:45	Original dataset	{'optimizer_name': 'nadam', 'learning_rate': 0...	{'conv_padding': 'same', 'conv_kernel_size': (...	{'input_shape': (128, 128), 'unit_size_rate': ...	{'batch_size': 64, 'epoch': 10}	[0.8573214411735535, 0.9330357313156128, 0.943...	[0.9342857003211975, 0.9471428394317627, 0.952...	Test	...	94.518885	320	30	1	349	0.958865	0.955714	0.955638	0.955714	0.955714
CNN_Adaptive Equalization	2023-09-25 16:44:23	Original dataset	{'optimizer_name': 'nadam', 'learning_rate': 0...	{'conv_padding': 'same', 'conv_kernel_size': (...	{'input_shape': (128, 128), 'unit_size_rate': ...	{'batch_size': 64, 'epoch': 10}	[0.8132143020629883, 0.9257143139839172, 0.943...	[0.9057142734527588, 0.9442856907844543, 0.959...	Test	...	92.421328	331	19	3	347	0.969553	0.968571	0.968555	0.968571	0.968571

- **Experiment 7**: Impact of Varying Unit Sizes in Neural Network Layers



- **Experiment 8**: Exploring Different Image Input Sizes

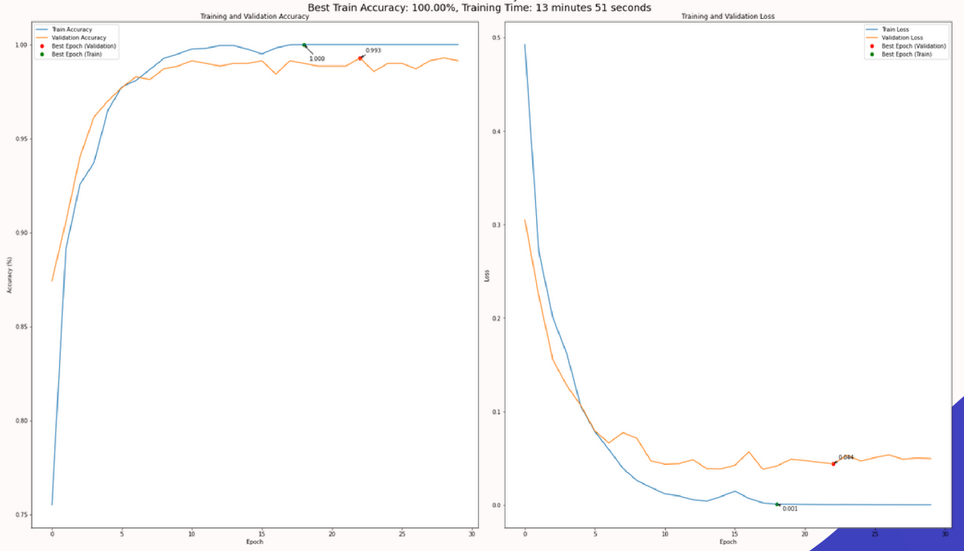




HYPERPARAMETER TUNING

TUNING AND GET THE BEST ARTIFACT

BuildBestArtifact
Ref. name : Originaldataset
Best Validation Accuracy: 99.29%
Best Train Accuracy: 100.00%, Training Time: 13 minutes 51 seconds



ConfigParameters :
OptimizerparametersConfiguration :
optimizer_name: adam
learning_rate: 0.0010000000474974513
beta1: 0.9
beta2: 0.999
epsilon: 1e-08
momentum: None
rho: None
HyperparametersConfiguration :
conv_padding: same
conv_kernel_size: (3, 3)
conv_stride: 1
pool_padding: same
pool_kernel_size: (2, 2)
pool_stride: 1
pooling_type: avg
ModelArchitectureConfiguration :
input_shape: (128, 128)
unit_size_rate: 0.05
ModelTrainingConfiguration :
batch_size: 64
epoch: 30

ModelSummary :
Model: "sequential_13"

Layer (type)	Output Shape	Param #
conv2d_39 (Conv2D)	(None, 128, 128, 1)	10
average_pooling2d_15 (AveragePooling2D)	(None, 128, 128, 1)	0
conv2d_40 (Conv2D)	(None, 128, 128, 3)	30
average_pooling2d_16 (AveragePooling2D)	(None, 128, 128, 3)	0
conv2d_41 (Conv2D)	(None, 128, 128, 6)	168
average_pooling2d_17 (AveragePooling2D)	(None, 128, 128, 6)	0
flatten_13 (Flatten)	(None, 98304)	0
dense_26 (Dense)	(None, 6)	589830
dropout_13 (Dropout)	(None, 6)	0
dense_27 (Dense)	(None, 1)	7

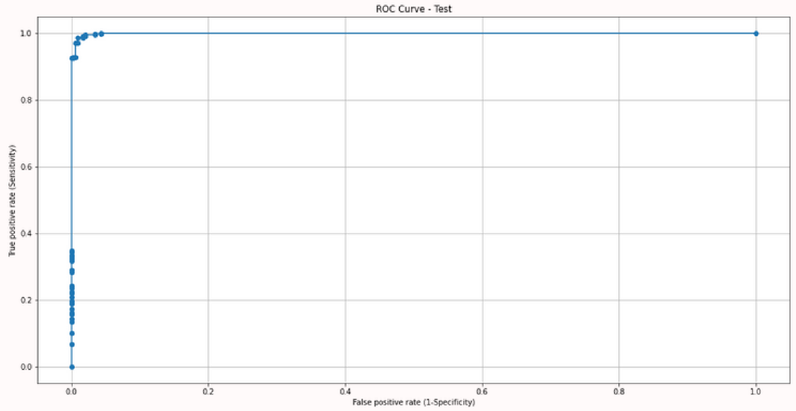
Total params: 590,045
Trainable params: 590,045
Non-trainable params: 0

99%

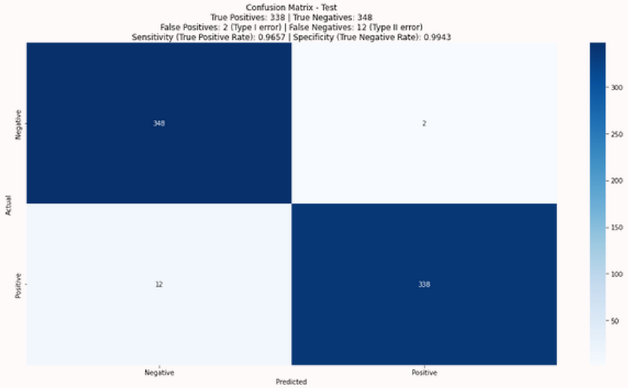
EVALUATION

PREDICTION

ROC



CONFUSION MATRIX

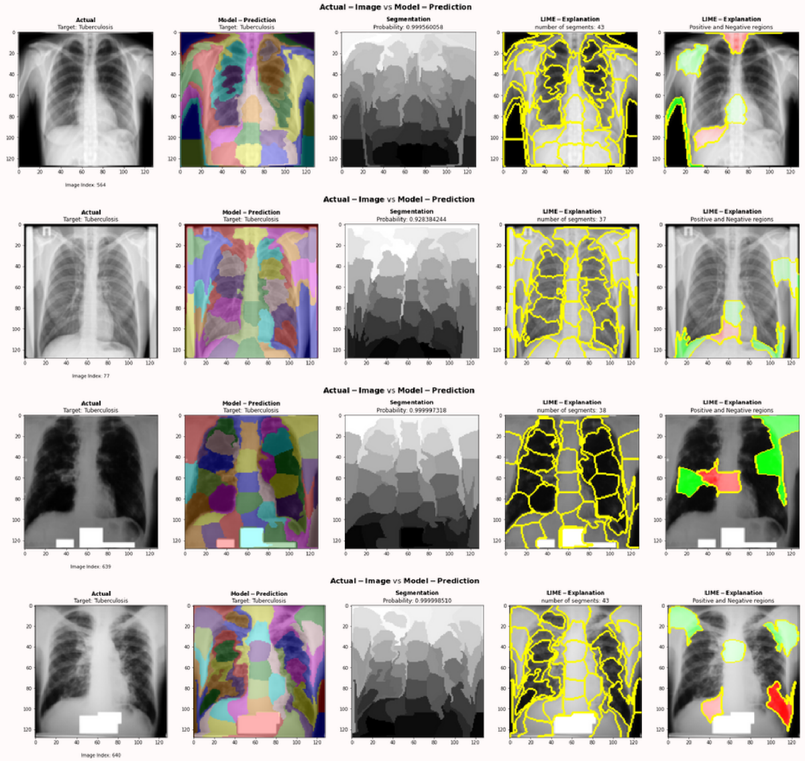


EXPLAINABILITY

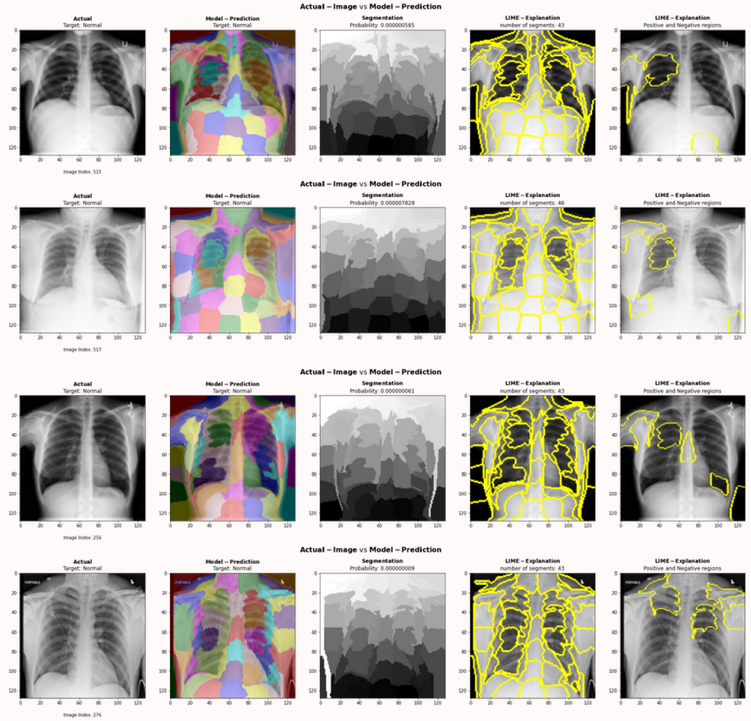
Lime Library

Local Interpretable Model-Agnostic Explanations (LIME)

Tuberculosis

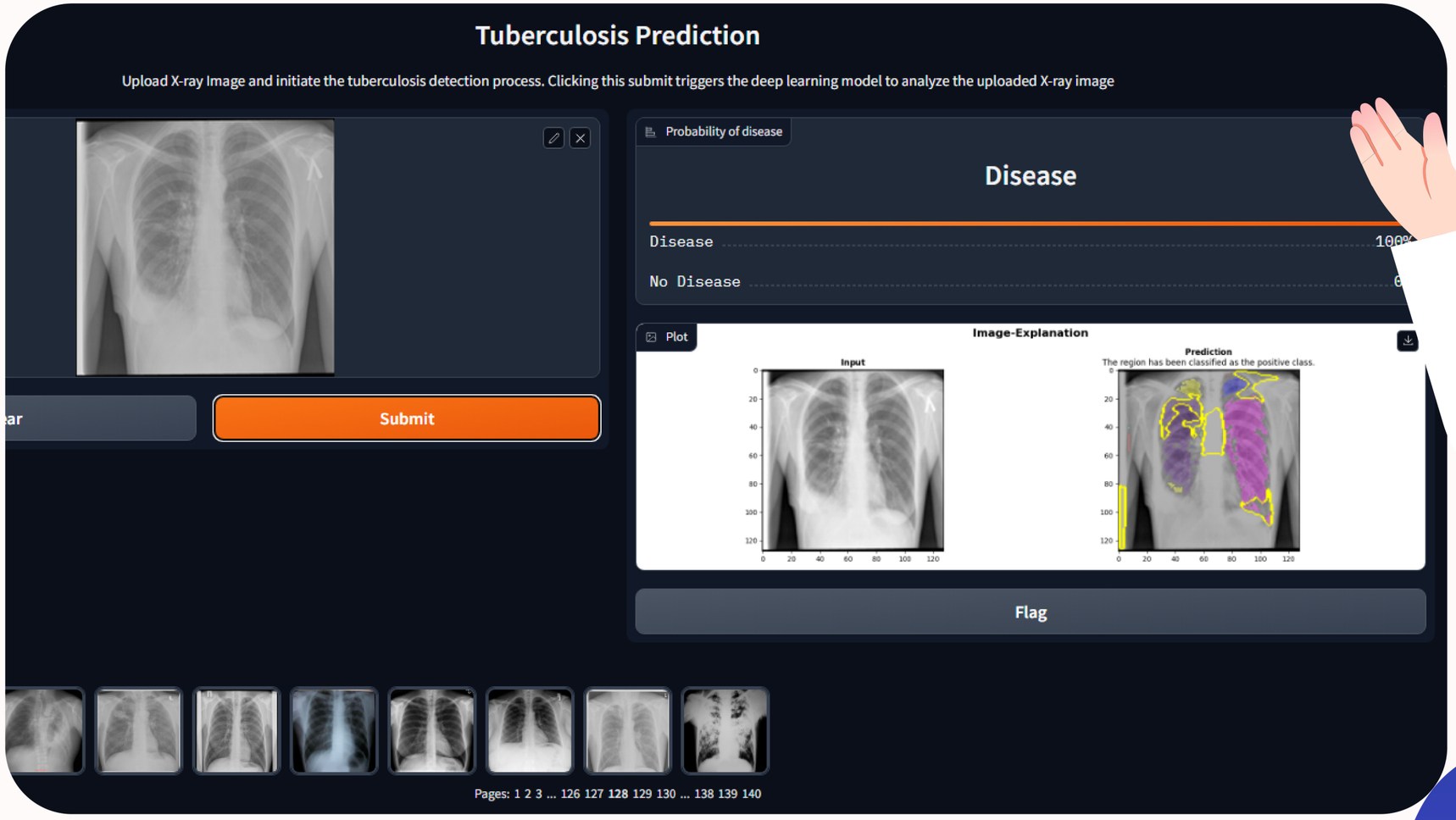


Normal



DEPLOYMENT

Gradio is the fastest way to demo your machine learning model with a friendly web interface so that anyone can use it, anywhere!



THANKS YOU

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