





2,150 Annual Cases

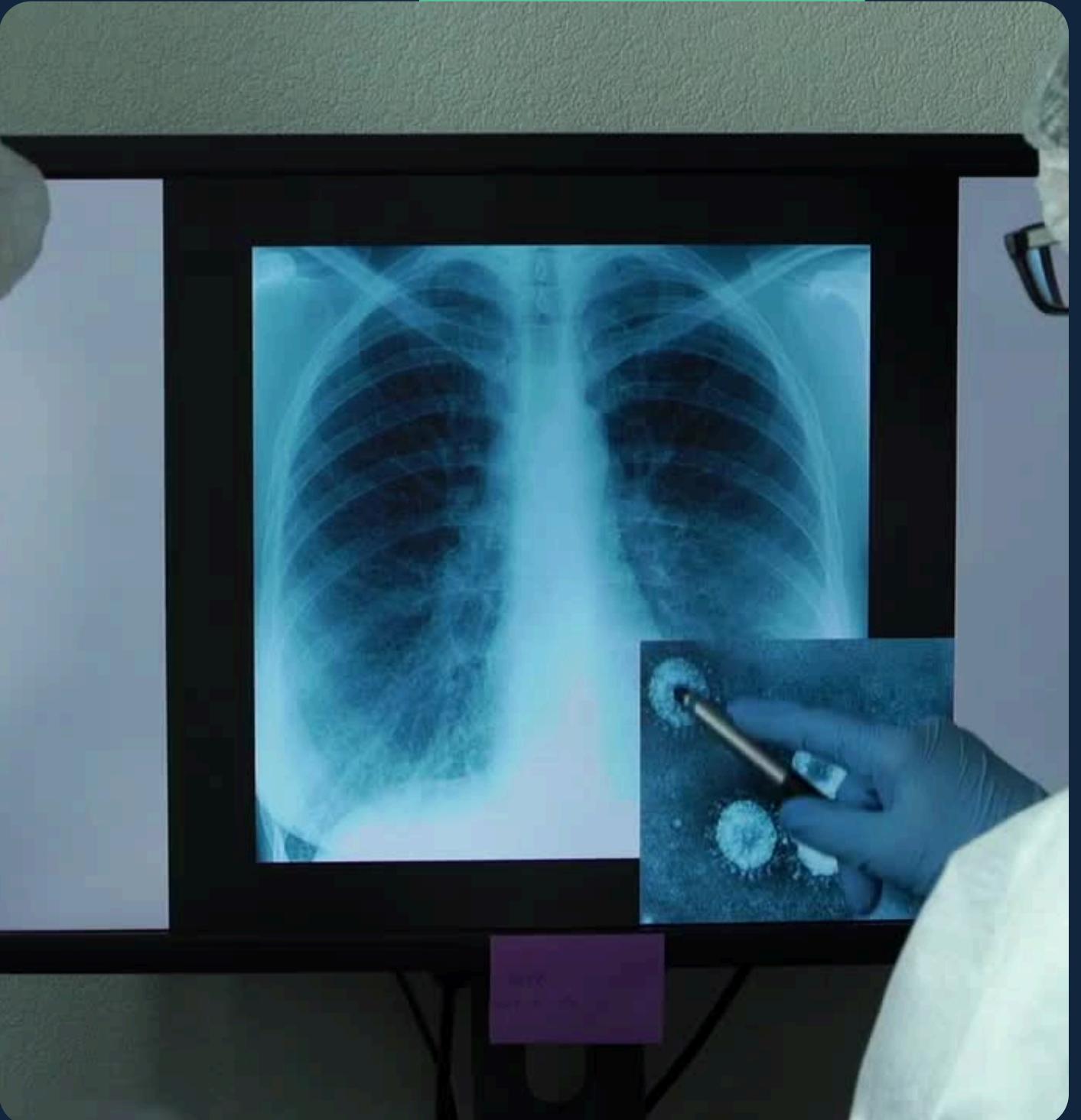
390 Deaths

18% of cases result in death



Radiologists are only ~65% accurate

- This means that 35 out of every 100 cases are either misdiagnosed as false positives or false negatives.
- False negatives can lead to irreversible complications
- False positives can lead to unnecessary medical expenses



Benefits of a \$2M medical investment from the Gates Foundation

support the scaling, deployment, training
detecting Pneumonia from X-ray Images

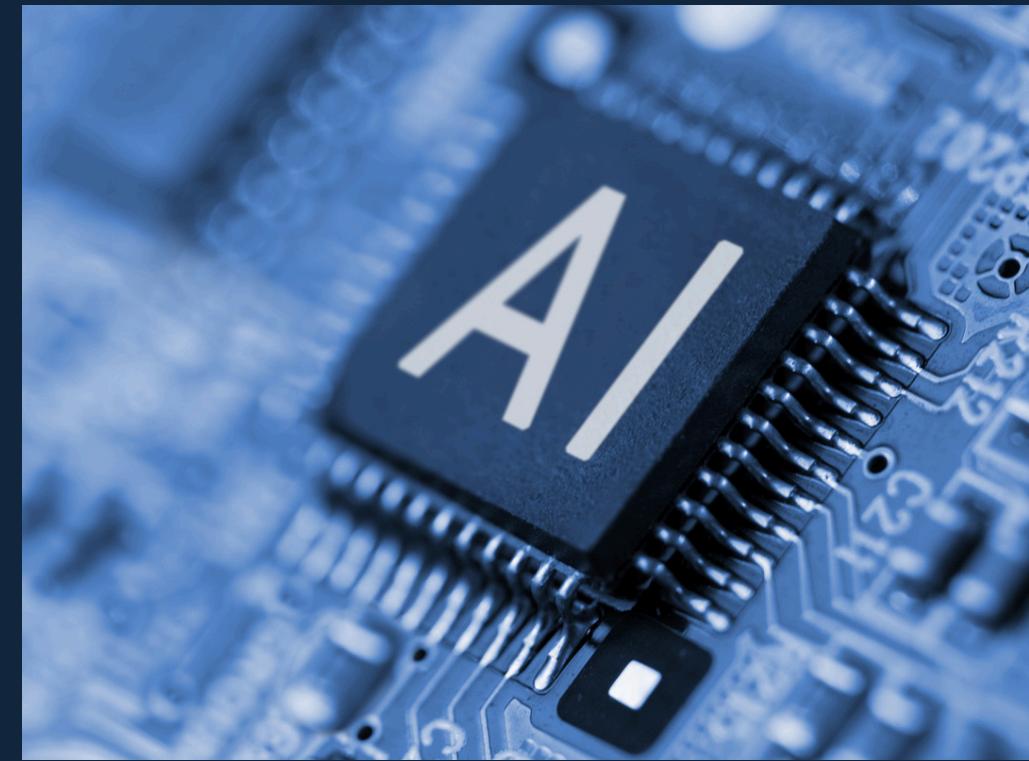


Agenda



BACKGROUND

MODEL DEVELOPMENT
AND COMPARISON



IMPLEMENTATION





Romania: Healthcare Landscape and Pneumonia Burden



Highest rate of child pneumonia deaths in the world



Brain drain issue



Uneven distribution



Quality of training



Low doctor-to population ratio



Model Building





Data Information



2,872 child patient X-ray images

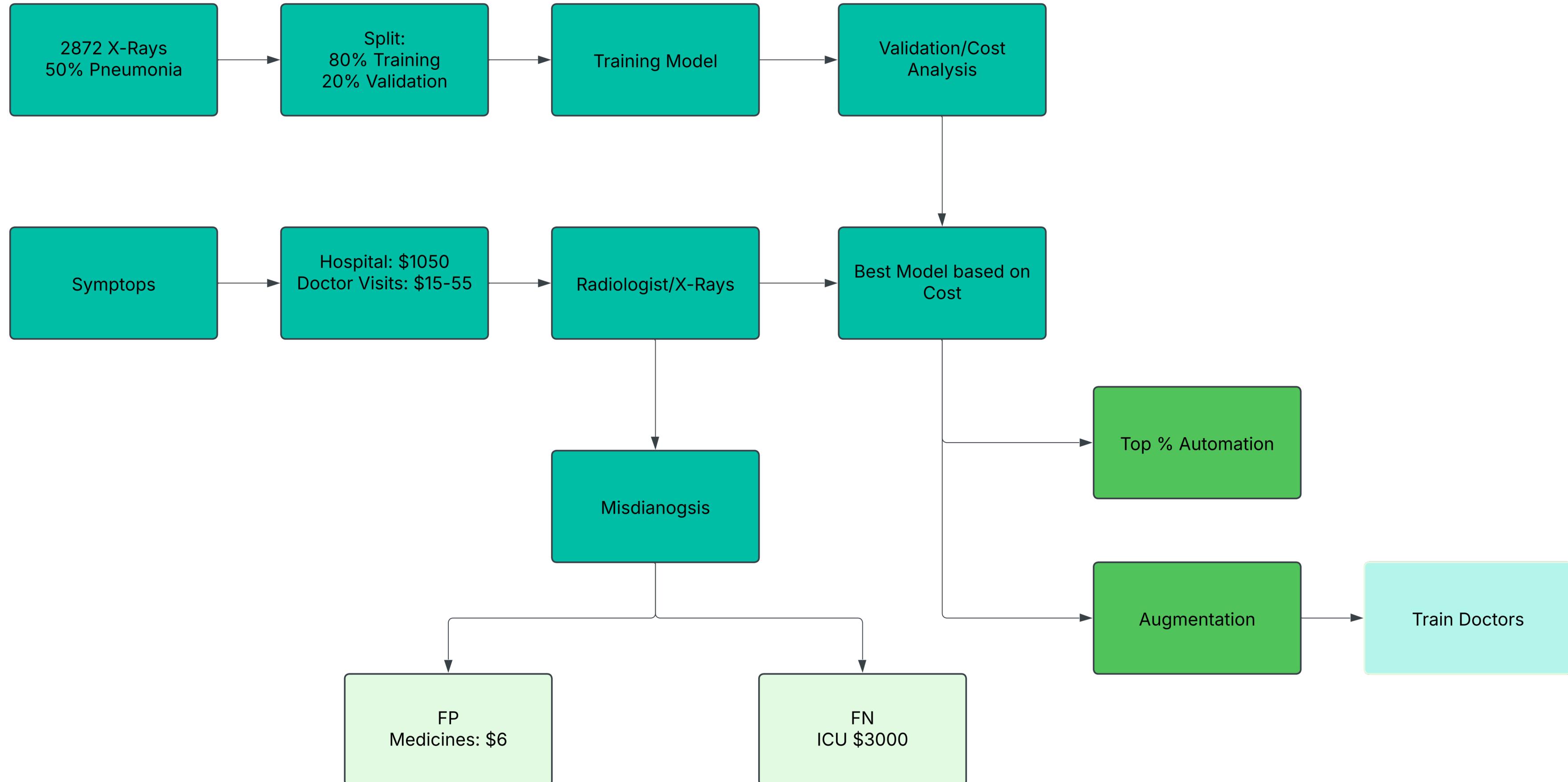


Evenly divided into healthy and pneumonia samples



80–20 split

Model Approach Flow Chart



Statistics

Total Under 5 Population	1,024,634
Acute Respiratory Infection Rate	0.134
Average Sensitivity	0.545
Average Specificity	0.764

Naive Models

	TN	TP	FP	FN	FPprop	FNProp	Total FP Cost	Total FN Cost	Total Cost	FP Cost	FN Cost	Annual
Untrustworthy Radiologist (65%)	156.96	219.268	131.04	67.732	0.227895652	0.117794783	\$32,854,805	\$65,502,012	\$98,356,817	\$1,050	\$4,050	137,301
Naïve Medicate the World (MTW)	0	287	288	0	0.500869565	0	\$72,208,364	\$0	\$72,208,364	\$1,050	\$4,050	137,301

Base Models

	TN	TP	FP	FN	FPprop	FNProp	Total FP Cost	Total FN Cost	Total Cost	FP Cost	FN Cost	Annual
Untrustworthy Radiologist (65%)	156.96	219.268	131.04	67.732	0.227895652	0.117794783	\$32,854,805	\$65,502,012	\$98,356,817	\$1,050	\$4,050	137,301
Naïve Medicate the World (MTW)	0	287	288	0	0.500869565	0	\$72,208,364	\$0	\$72,208,364	\$1,050	\$4,050	137,301
Decision Tree	244	234	52	42	0.090909091	0.073426573	\$13,106,000	\$40,830,232	\$53,936,232	\$1,050	\$4,050	137,301
Random Forest	275	260	21	16	0.036713287	0.027972028	\$5,292,808	\$15,554,374	\$20,847,182	\$1,050	\$4,050	137,301
XG Boost	274	261	22	15	0.038461538	0.026223776	\$5,544,846	\$14,582,226	\$20,127,072	\$1,050	\$4,050	137,301
Neural Network	283	250	13	26	0.022727273	0.045454545	\$3,276,500	\$25,275,858	\$28,552,358	\$1,050	\$4,050	137,301
CNN (Base Line)	270	271	18	16	0.031304348	0.027826087	\$4,513,023	\$15,473,221	\$19,986,244	\$1,050	\$4,050	137,301

CNN Model Development

Adjusted hyper parameters

- Number of layers
- Number of filters
- Kernel size
- Dropout value
- Max pooling
- Batch size
- Number of epochs

CNN Model Development

- Including data augmentation
- Adjusted augmentation parameters



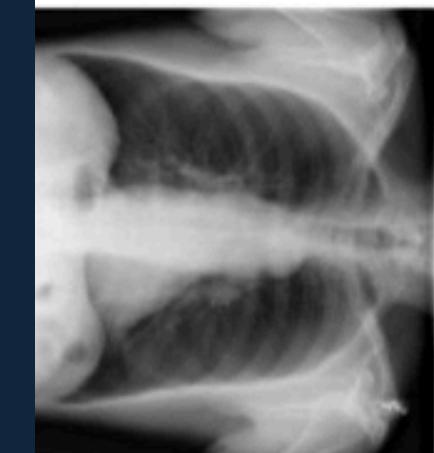
(A) Original



(B) Type 1



(C) Type 2



(D) Type 3



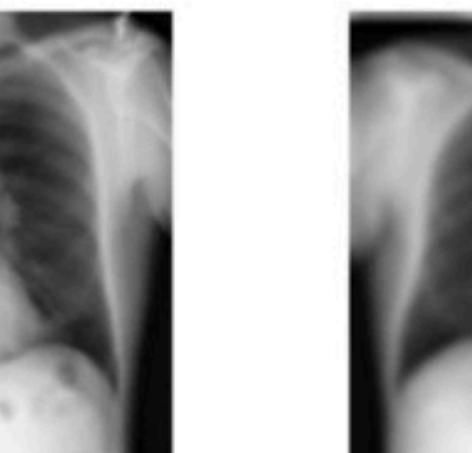
(E) Type 4



(F) Type 5



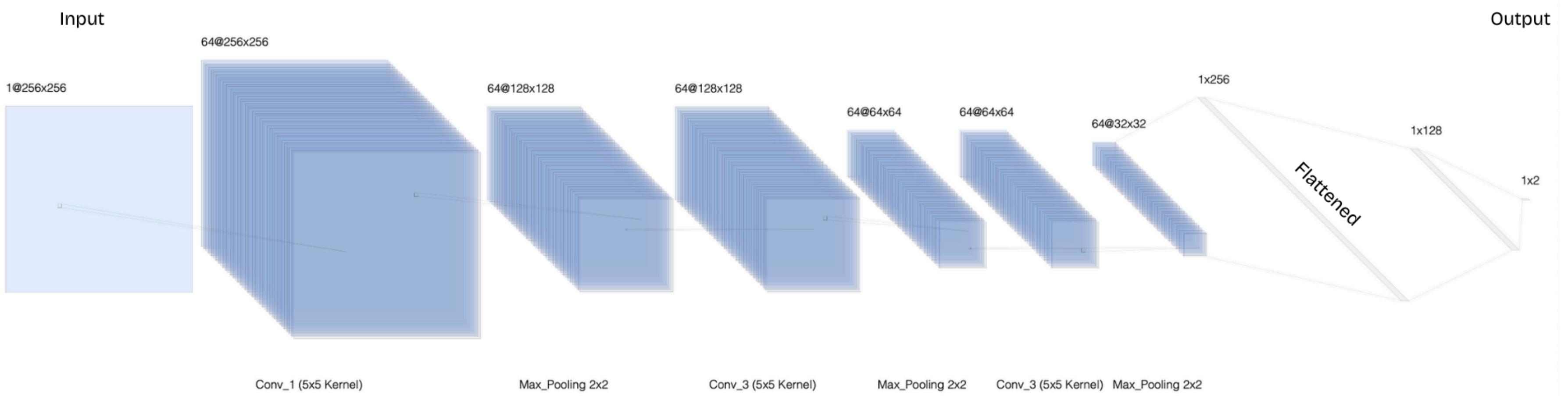
(G) Type 6



(H) Type 7

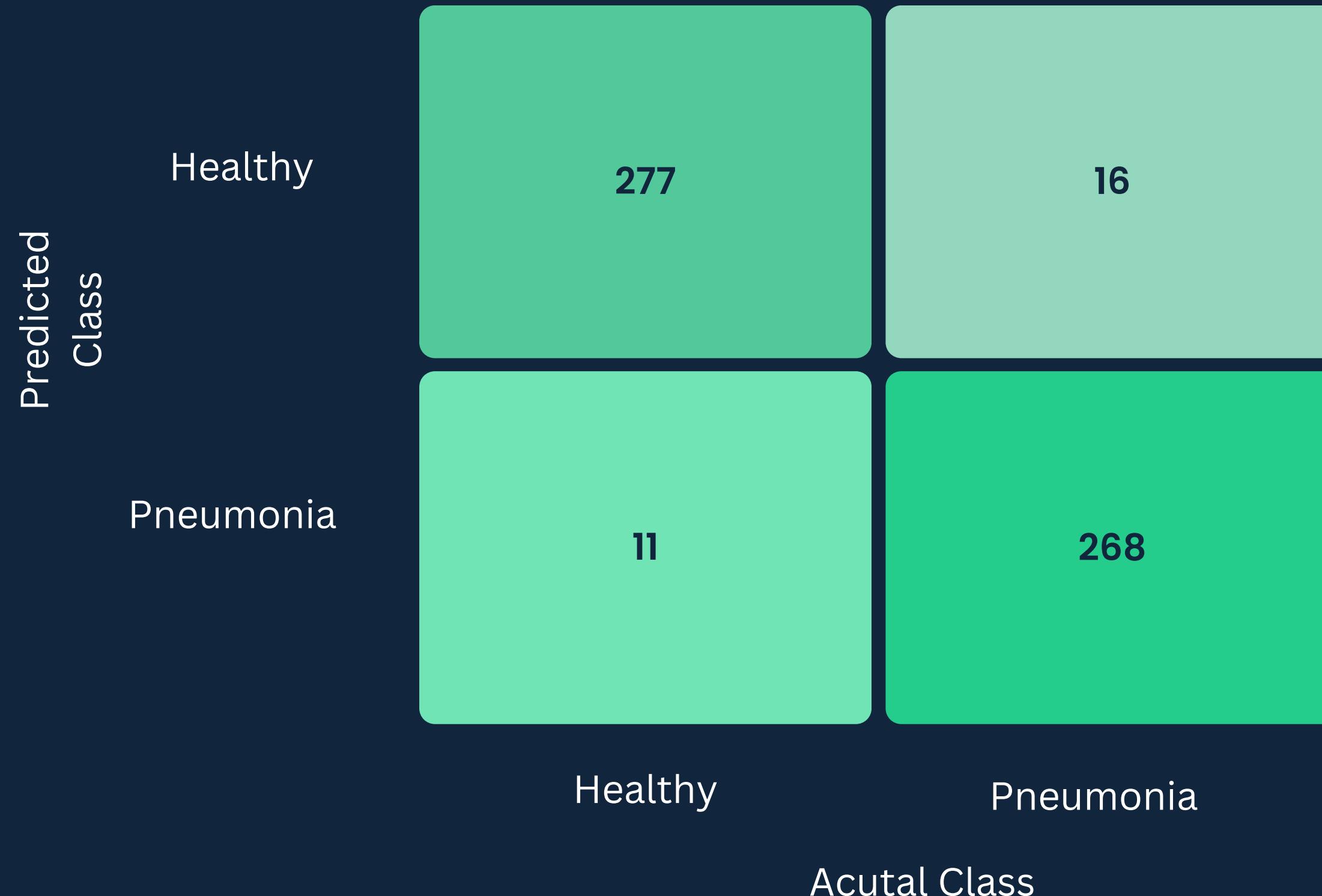
CNN Model Development

MaxPooling	Dropout	SetSeed	NumLayers	numFilters	kernelSize	dropout value	MaxPooling	batchSize	LR	#epochs	use DA	ModelUsed	BestEpoch	EpochACC	EpoccAUC	KaggleScore
Yes L1	Yes	0	2	64	5	0.2	2	32	0.01	7	TRUE	Parameterized	5	86.96	94.81	0.9682
Yes L1	Yes	0	2	64	5	0.2	2	32	0.01	10	TRUE	Parameterized	3	93.57	98.03	0.9866
Yes L1	Yes	0	3	64	5	0.3	2	32	0.001	10	TRUE	Parameterized	7	93.74	98.4	0.9882
Yes L1	Yes	0	3	64	5	0.3	2	32	0.001	20	TRUE	Parameterized	15	93.57	98.21	0.9909
Yes L1	Yes	0	3	64	5	0.3	2	32	0.0001	25	TRUE	Parameterized	23	93.22	98.5	0.9971
Yes L1	Yes	0	3	64	5	0.3	2	32	0.0001	30	TRUE	Parameterized	29	93.04	98.23	0.9929
Yes L1	Yes	1	3	64	5	0.3	2	32	0.0001	33	TRUE	Parameterized	32	95.28	98.93	0.9983



Best Model

Tunned CNN Confusion Matrix



All Models

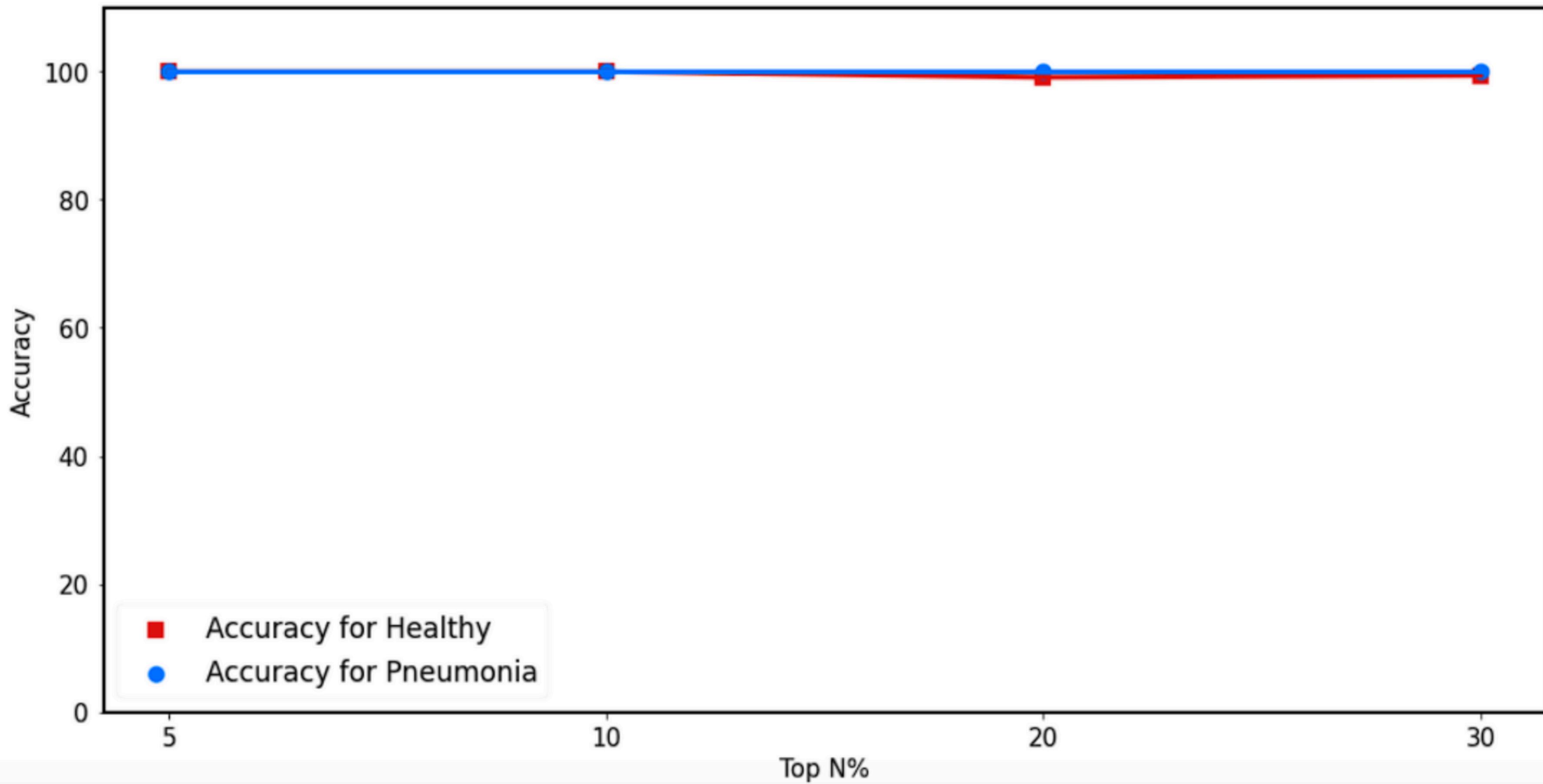
	TN	TP	FP	FN	FPprop	FNProp	Total FP Cost	Total FN Cost	Total Cost	FP Cost	FN Cost	Annual
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Naïve Medicate the World (MTW)	0	287	288	0	0.500869565	0	\$72,208,364	\$0	\$72,208,364	\$1,050	\$4,050	137,301
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CNN Tuned (Best Model)	268	277	11	16	0.019230769	0.027972028	\$2,772,423	\$15,554,374	\$18,326,797	\$1,050	\$4,050	137,301



Implementation



+ Accuracy for top 5 percent predictions for healthy: 100.00, pneumonia: 100.00
+ Accuracy for top 10 percent predictions for healthy: 100.00, pneumonia: 100.00
+ Accuracy for top 20 percent predictions for healthy: 99.12, pneumonia: 100.00
+ Accuracy for top 30 percent predictions for healthy: 99.41, pneumonia: 100.00





\$2M Budget Allocation



Model development and enhancement – \$500,000



Deployment and implementation – \$600,000



Training healthcare professionals – \$400,000



Validation and regulatory approval – \$300,000



Monitoring, evaluation, and future scaling – \$200,000

**Proactively addressing these barriers,
our AI model can provide:**

- Sustained improvements in pediatric pneumonia detection
- Reduce ICU admissions
- Significantly lower healthcare expenditures.



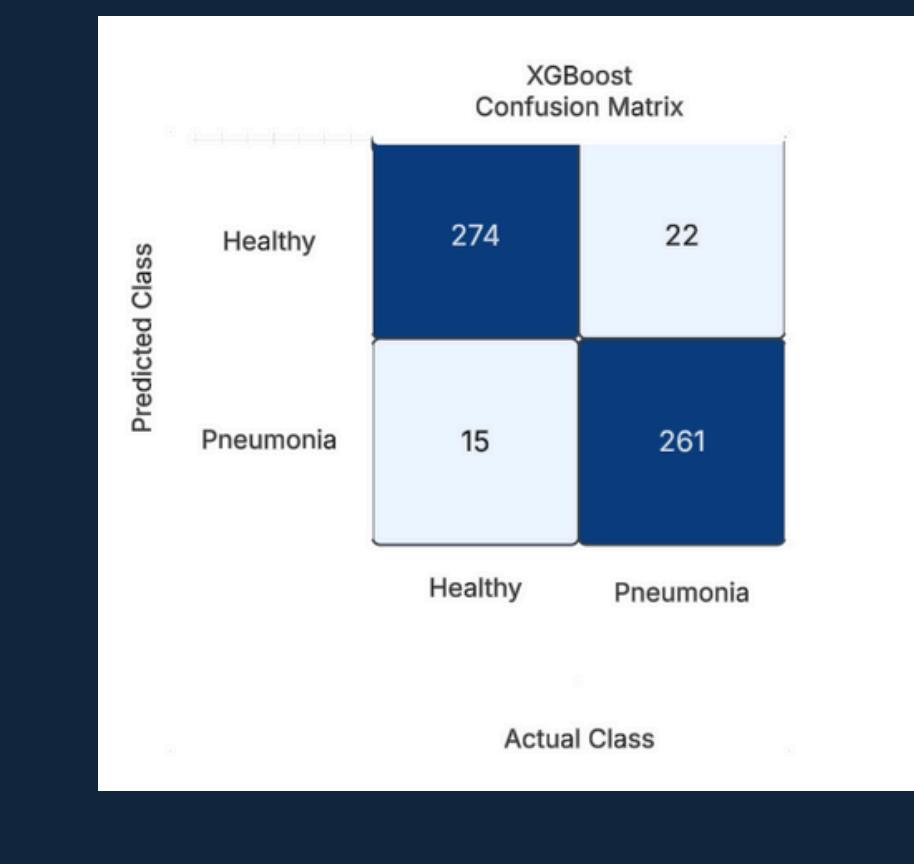
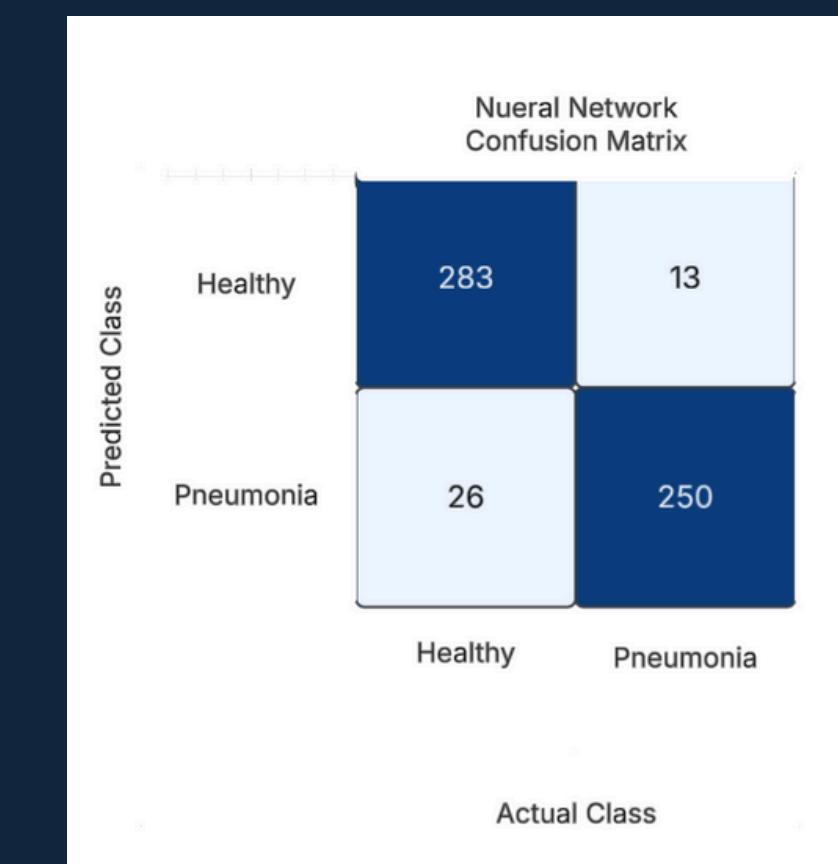
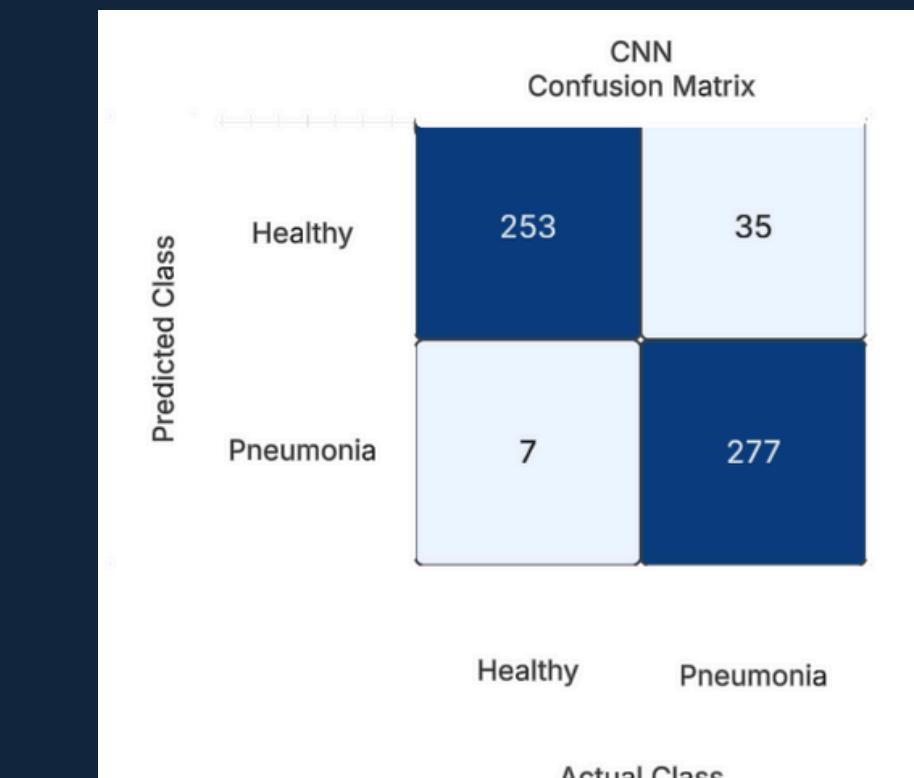
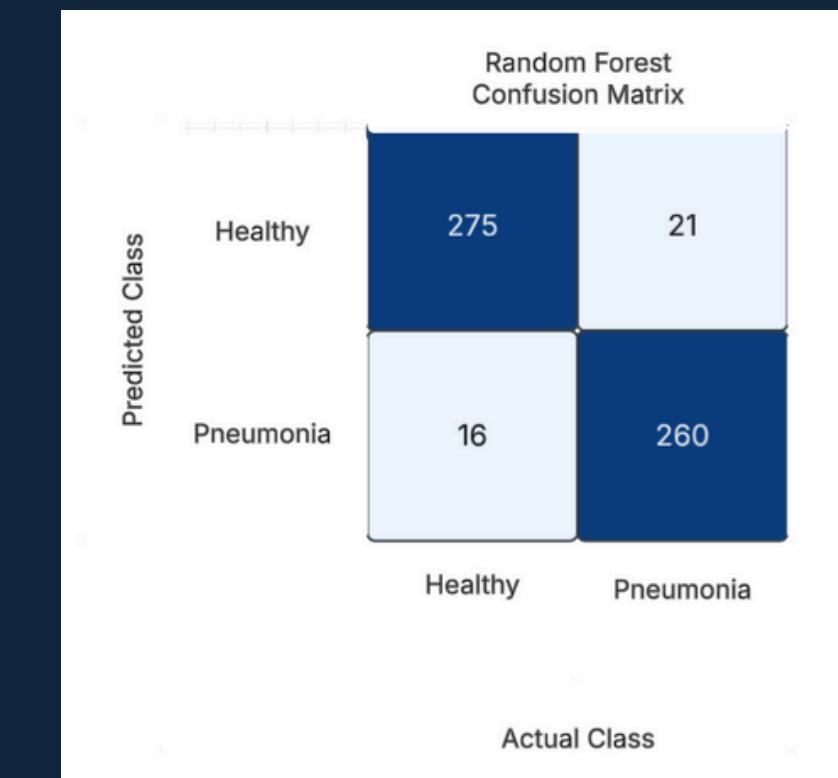
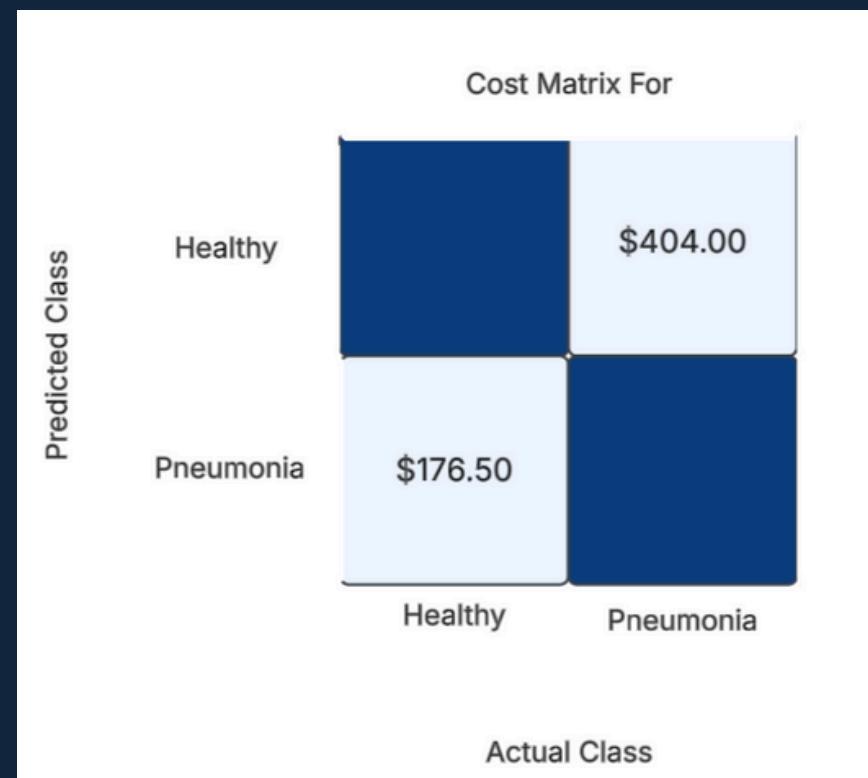


Appendix

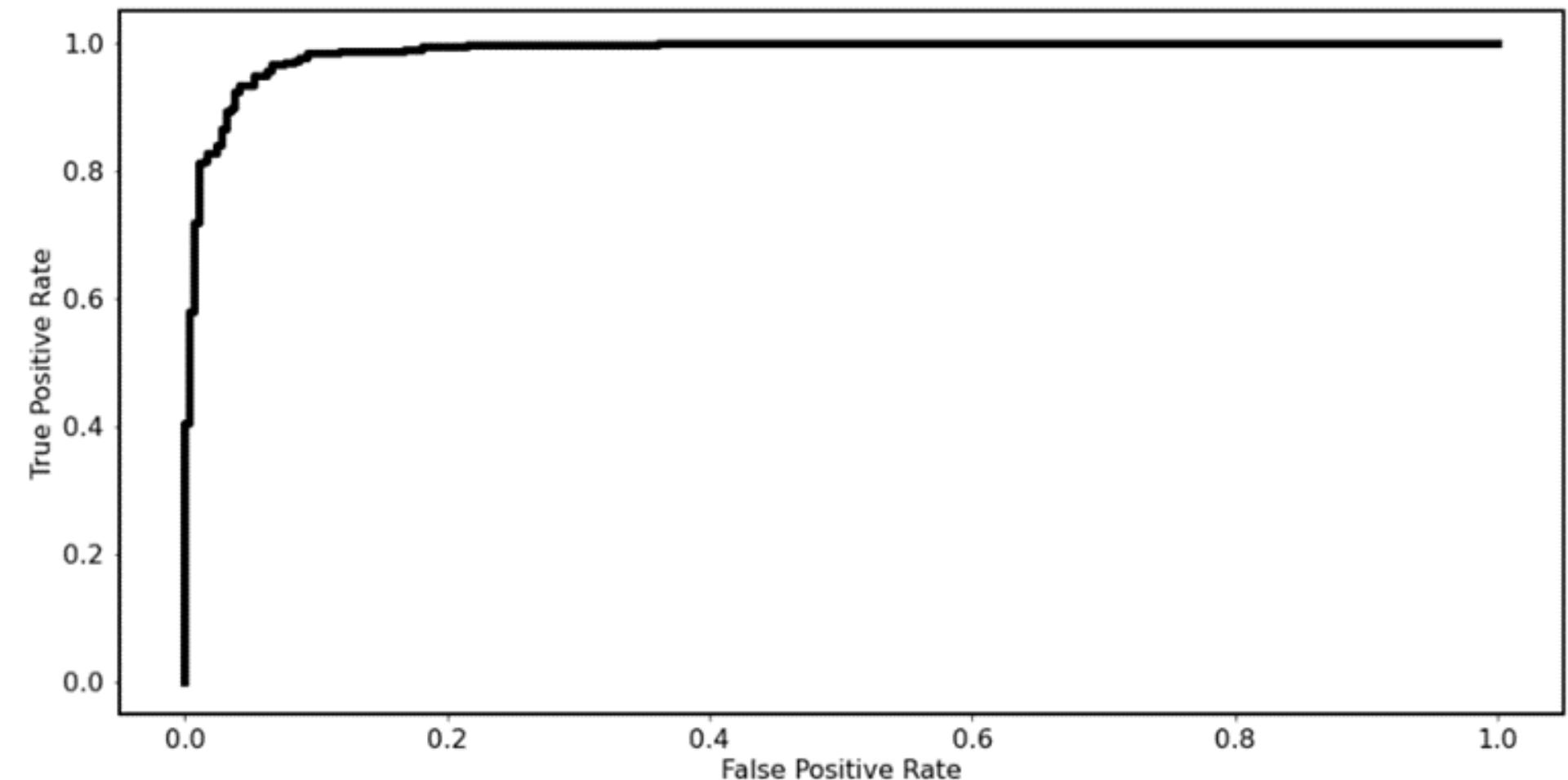
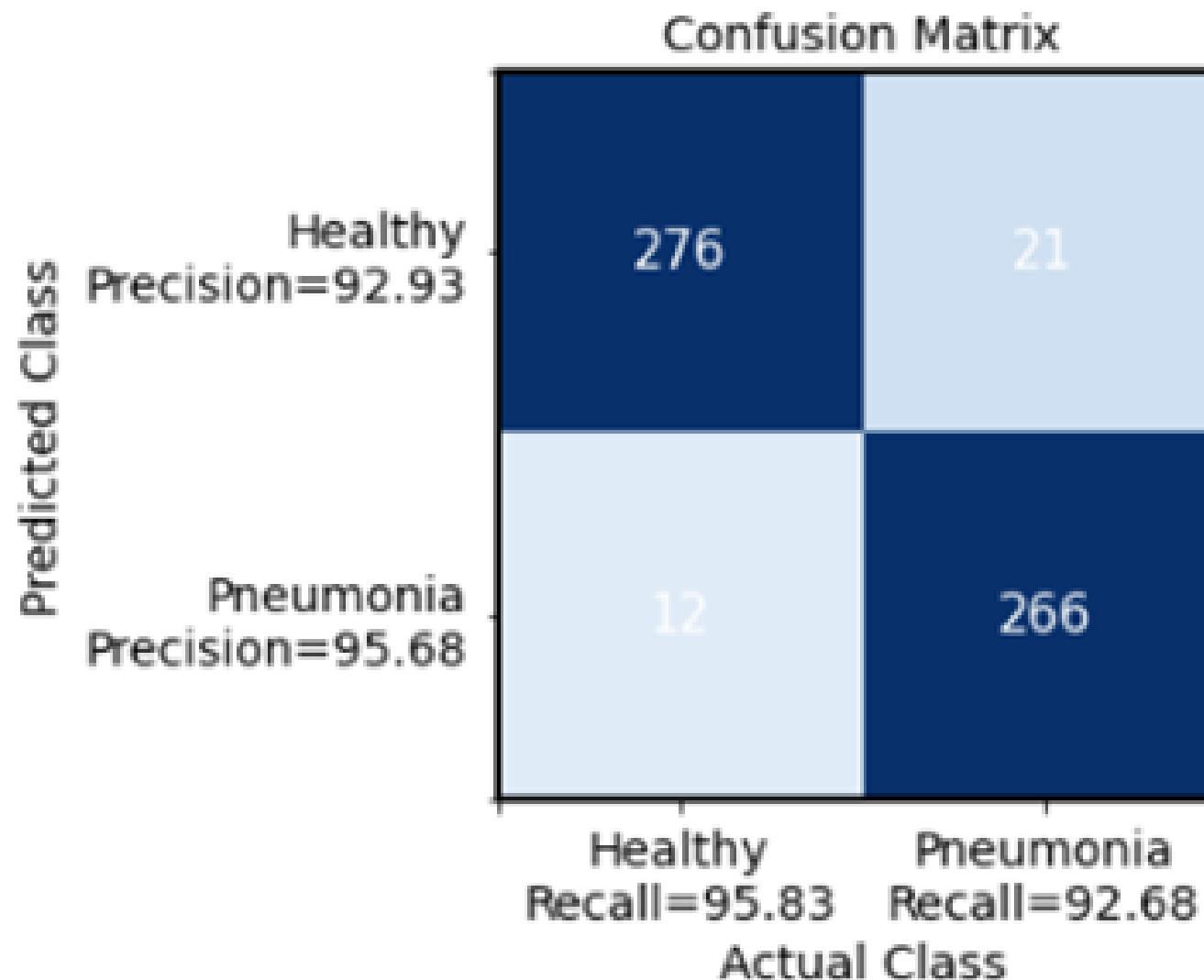
Appendix 1 - More complete Excel Sheet

Data Augmentation	MaxPooling	Dropout	SetSeed	NumLayers	numFilters	kernelSize	dropout value	MaxPooling	batchSize	LR	epochs	use DA	ModelUsed	BestEpoch	EpochACC	EpochAUC	KaggleScore
No	Yes L1	Yes	0	1	64	5	0.4	3	16	0.0001	3	FALSE	Parameterized	0	92.35	96.69	0.9766
No	Yes L1	Yes	0	1	64	5	0.3	2	32	0.1	3	FALSE	Parameterized	1	93.39	98.5	0.9872
No	Yes L1	Yes	0	1	64	5	0.3	2	32	0.1	5	FALSE	Parameterized	4	93.74	98.19	0.9852
No	Yes L1	Yes	0	2	64	5	0.3	2	32	0.1	10	FALSE	Parameterized	5	93.91	98.09	0.9874
No	Yes L1	Yes	0	2	64	5	0.2	2	32	0.01	7	TRUE	Parameterized	5	86.96	94.81	0.9682
Yes	Yes L1	Yes	0	2	64	5	0.2	2	32	0.01	10	TRUE	Parameterized	3	93.57	98.03	0.9866
Yes	Yes L1	Yes	0	3	64	5	0.3	2	32	0.001	10	TRUE	Parameterized	7	93.74	98.4	0.9882
Yes	Yes L1	Yes	0	3	64	5	0.3	2	32	0.001	20	TRUE	Parameterized	15	93.57	98.21	0.9909
Yes	Yes L1	Yes	0	3	64	5	0.3	2	32	0.001	25	TRUE	Parameterized	5	93.39	97.81	0.9852
Yes	Yes L1	Yes	0	3	64	5	0.3	2	32	0.0001	25	TRUE	Parameterized	16	92.7	98.28	0.9961
Yes	Yes L1	Yes	0	3	64	5	0.3	2	32	0.0001	25	TRUE	Parameterized	22	93.91	98.34	0.9965
Yes	Yes L1	Yes	0	3	64	5	0.3	2	32	0.0001	25	TRUE	Parameterized	23	93.22	98.5	0.9971
Yes	Yes L1	Yes	0	3	64	5	0.3	2	32	0.0001	30	TRUE	Parameterized	29	93.04	98.23	0.9929
Yes	Yes L1	Yes	0	3	64	3	0.3	2	32	0.0001	25	TRUE	Parameterized	21	93.91	98.4	0.9914
Yes	Yes L1	Yes	0	3	64	5	0.3	2	32	0.00001	25	TRUE	Parameterized	21	94.61	98.28	0.9887
Yes	Yes L1	Yes	0	3	64	5	0.3	3	32	0.00001	25	TRUE	Parameterized	19	93.56	98.27	0.9857
Yes	Yes L1	Yes	0	3	64	5	0.3	2	64	0.0001	25	TRUE	Parameterized	23	94.09	98.65	0.99
Yes	Yes L1	Yes	0	3	64	5	0.3	2	64	0.0001	25	TRUE	Parameterized	19	94.44	98.47	0.99
Yes	Yes L1	Yes	0	3	64	5	0.3	2	64	0.0001	25	TRUE	Parameterized	11	93.04	98.15	0.987
Yes	Yes L1	Yes	0	3	64	5	0.3	2	64	0.0001	25	TRUE	Parameterized	21	92.17	97.92	0.9862
Yes	Yes L1	Yes	0	3	64	5	0.3	2	64	0.0001	25	TRUE	Parameterized	21	94.09	98.57	0.9927
Yes	Yes L1	Yes	0	2	64	5	0.3	2	64	0.0001	25	TRUE	Parameterized	17	94.09	98.61	0.9922
Yes	Yes L1	Yes	0	3	64	5	0.3	2	32	0.0001	25	TRUE	Parameterized	13	94.26	98.67	0.9914
Yes	Yes L1	Yes	1	3	64	5	0.3	2	32	0.0001	33	TRUE	Parameterized	32	95.28	98.93	0.9983

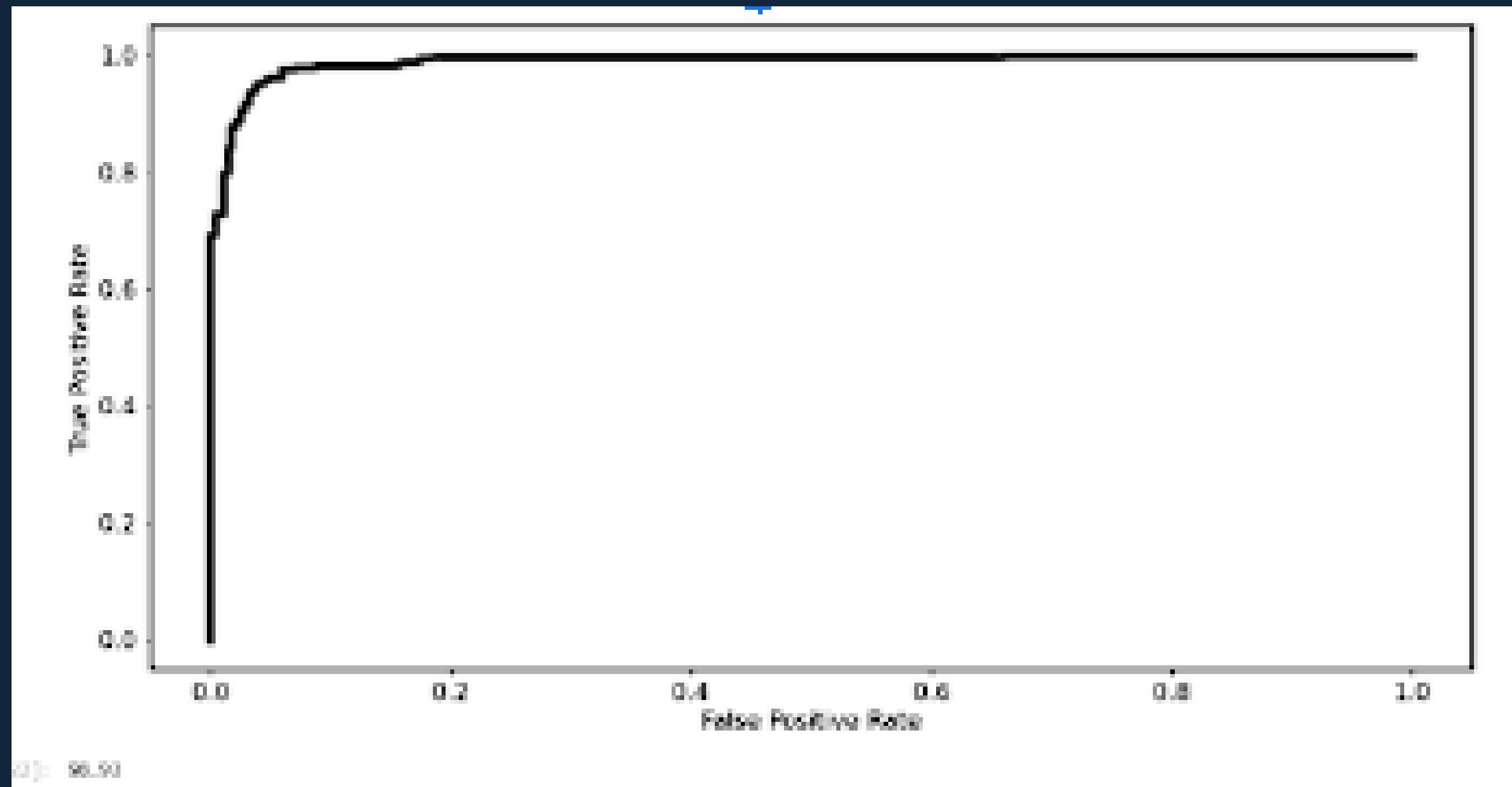
Appendix 3 – Confusion Matrices for All Models



Appendix 3 – 2nd Best CNN Model



Appendix 4 - ROC of Best Model



References

Author, A. A., Author, B. B., & Author, C. C. (2019). *Title of the article*. *American Journal of Roentgenology*, 213(3), 123–130.
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