

Detecting Pneumonia in Chest Radiographs

Spencer Hadel

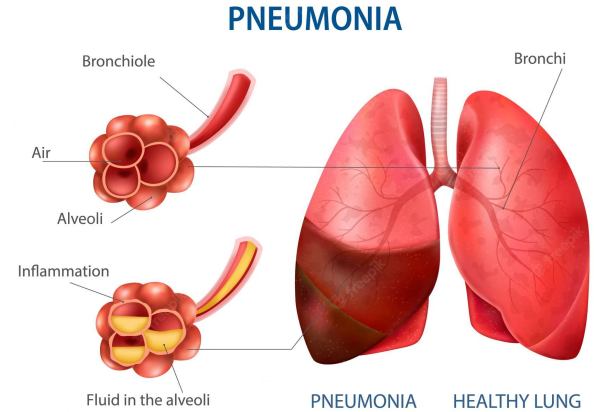
Outline

- The Problem
 - Data
 - Methods
 - Results
 - Conclusions
-

The Problem

According to the WHO, *Pneumonia*:

- Accounts for **14% of all deaths of children under 5**
- **Can be prevented**, but only **one third** of children who have it **receive the antibiotics they need**
- **Can be prevented** with simple interventions
- **Can be treated** with low-cost, low-tech medication/ care
- **Killed 740,180 children in 2019**
- That means **488,518 of those children** needed **proper treatment**, which requires **accurate diagnosis**



The Problem

- **Médecins Sans Limites (MSL)**, an AI-based medical research company, hopes to use **Convolutional Neural Networks** to identify patients with pneumonia based on **Chest Radiographs**
- We have created a **Convolutional Neural Network** that can **help save hundreds of thousands of lives per year**



Data - Chest Radiographs



- 5,863 Total Images
- X-Rays from pediatric patients 1-5 years old
- Classes reduced to 2:
 - NORMAL (1,583 x-rays)
 - PNEUMONIA (4,280 x-rays)

Data

- Not easy to distinguish by eye
- Requires Trained Medical Professionals

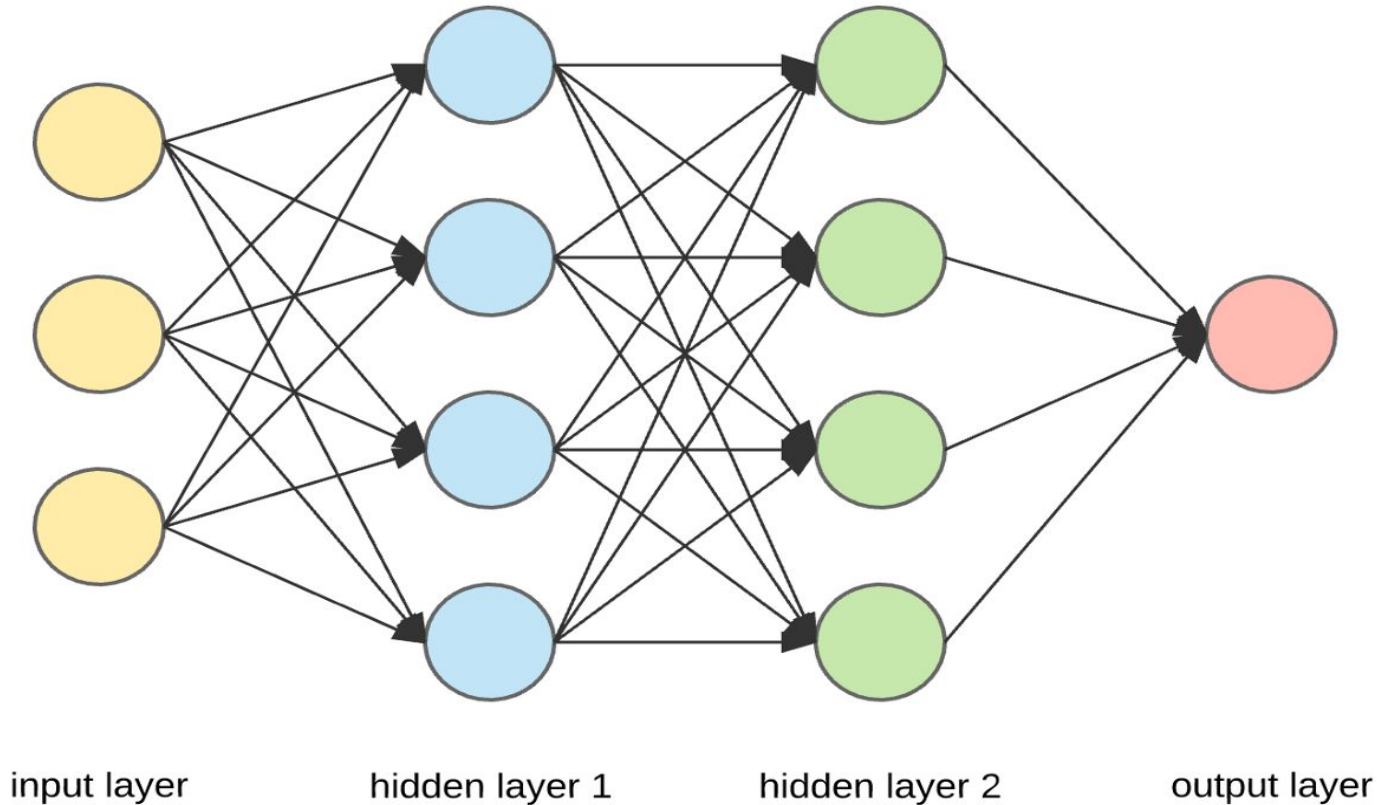
NORMAL



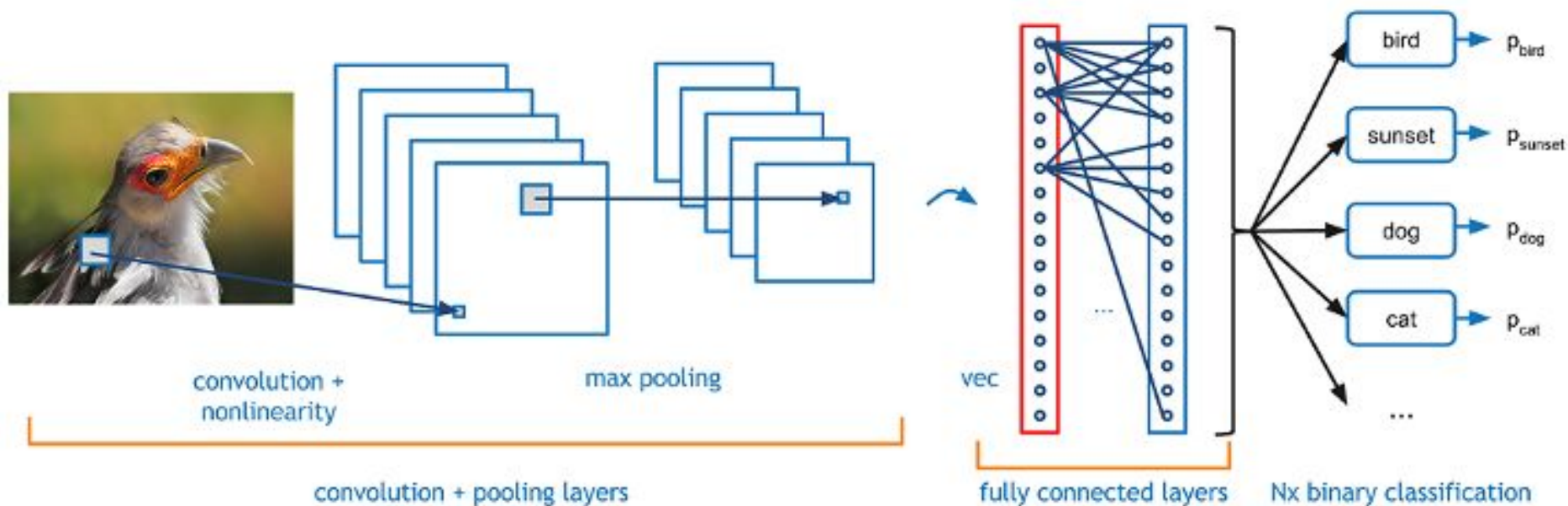
PNEUMONIA



Methods - Deep Learning Neural Networks



Methods - Convolutional Neural Network

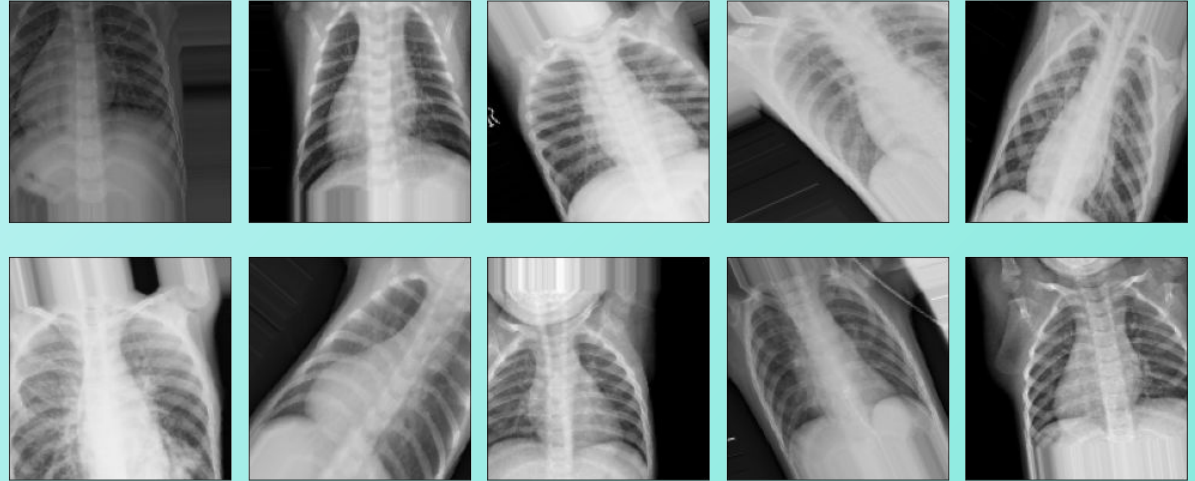


Methods - Data Augmentation

Training images were randomly altered:

- Rotation
- Width
- Height
- Zoom
- Shear

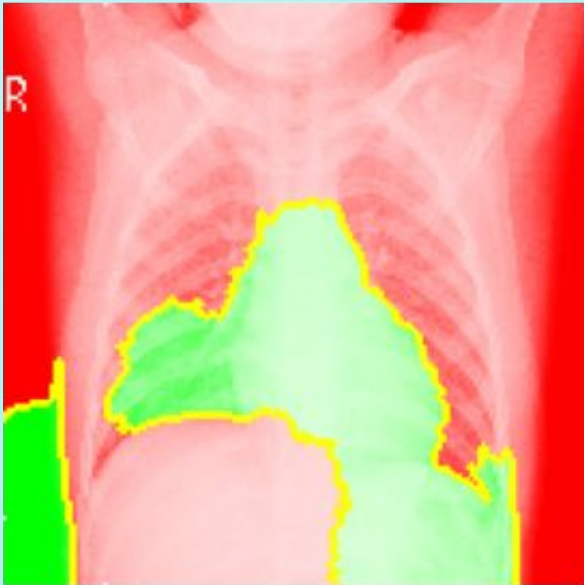
Example - Augmented Training Images



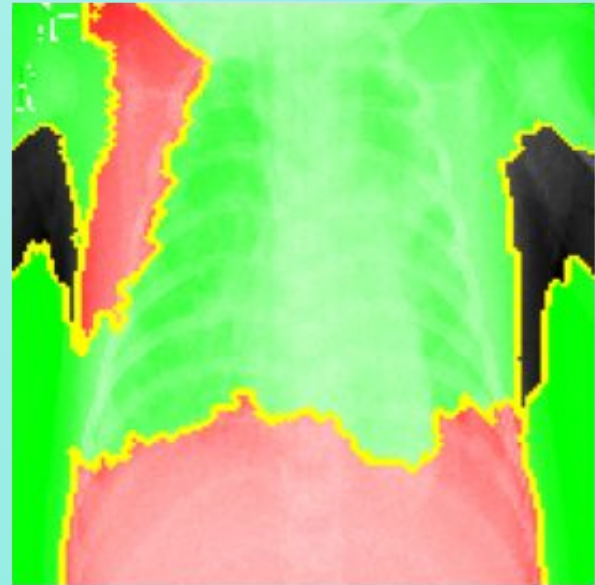
Methods - Understanding Model Prediction

★ Green indicates potential patterns indicating pneumonia

NORMAL



PNEUMONIA



Results - Baseline Model

Accuracy:

Percentage of *successful predictions* by the model:

74%

Sensitivity:

Percentage of sick patients *successfully identified*:

99%

TRUE LABELS

Healthy

Pneumonia

Correctly Diagnosed: Healthy 76	Incorrectly Diagnosed: Sick 158
Incorrectly Diagnosed: Healthy 2	Correctly Diagnosed: Sick 388

Healthy

Pneumonia

PREDICTED LABELS

Results - Baseline Model

TRUE NEGATIVES

Too Low, needs to be more accurate!

FALSE NEGATIVES

We want to **make sure this stays low**.
The lower it is, the more potential **lives can be saved!**

TRUE LABELS	Healthy	Pneumonia
	Healthy	Pneumonia
Healthy	Correctly Diagnosed: Healthy 76	Incorrectly Diagnosed: Sick 158
Pneumonia	Incorrectly Diagnosed: Healthy 2	Correctly Diagnosed: Sick 388
		PREDICTED LABELS
		Healthy Pneumonia

Results - Baseline Model

FALSE POSITIVES

Too High, could lead to *untrustworthy results* or *waste of resources*

TRUE POSITIVES

Many Accurate Diagnoses, but only because model *fails to predict healthy patients most of the time*

		PREDICTED LABELS	
		Healthy	Pneumonia
TRUE LABELS	Healthy	Correctly Diagnosed: Healthy 76	Incorrectly Diagnosed: Sick 158
	Pneumonia	Incorrectly Diagnosed: Healthy 2	Correctly Diagnosed: Sick 388

Results - Final Model

Accuracy:

Percentage of *successful predictions* by the model:

85%

Sensitivity:

Percentage of sick patients *successfully identified*:

99%

TRUE LABELS	Healthy	Pneumonia
	Healthy	Pneumonia
Healthy	Correctly Diagnosed: Healthy 144	Incorrectly Diagnosed: Sick 90
Pneumonia	Incorrectly Diagnosed: Healthy 3	Correctly Diagnosed: Sick 387

Results - Final Model

TRUE NEGATIVES

More Correct Healthy Diagnoses, prevents unnecessary use of resources

FALSE NEGATIVES

Very Few patients misdiagnosed as Healthy, leading to **more lives saved**

TRUE LABELS	Healthy	Pneumonia
	Healthy	Pneumonia
Healthy	Correctly Diagnosed: Healthy 144	Incorrectly Diagnosed: Sick 90
Pneumonia	Incorrectly Diagnosed: Healthy 3	Correctly Diagnosed: Sick 387
	Healthy	Pneumonia
	PREDICTED LABELS	

Results - Final Model

FALSE POSITIVES

Significantly Lower,
Leading to *higher accuracy* and *less waste of resources*

TRUE POSITIVES

Maintains Accurate Sick Diagnoses while
also *increasing accuracy of healthy diagnoses*

TRUE LABELS		PREDICTED LABELS	
		Healthy	Pneumonia
Healthy	Healthy	Correctly Diagnosed: Healthy 144	Incorrectly Diagnosed: Sick 90
	Pneumonia	Incorrectly Diagnosed: Healthy 3	Correctly Diagnosed: Sick 387

Conclusion

- Model accuracy increased by 11% while **maintaining high sensitivity**
- Equates to **over 483,000 lives potentially saved each year**
- Can help **easily identify pneumonia** so that children in need have access to **low cost, life saving care**

Next Steps

- Deploy Neural Network model along with easy-access, affordable care to regions in need
- Additional data collection for further fine tuning to increase performance
- Adjust model for wider demographic of patients, such as different age groups
- Create classifiers that can identify multiple illnesses, or multiple degrees of illness

Thank you

Email: shadel96@gmail.com

GitHub: [@shadel96](https://github.com/shadel96)

LinkedIn: [linkedin.com/in/spencer-hadel/](https://www.linkedin.com/in/spencer-hadel/)