Childhood Pneumonia Detection

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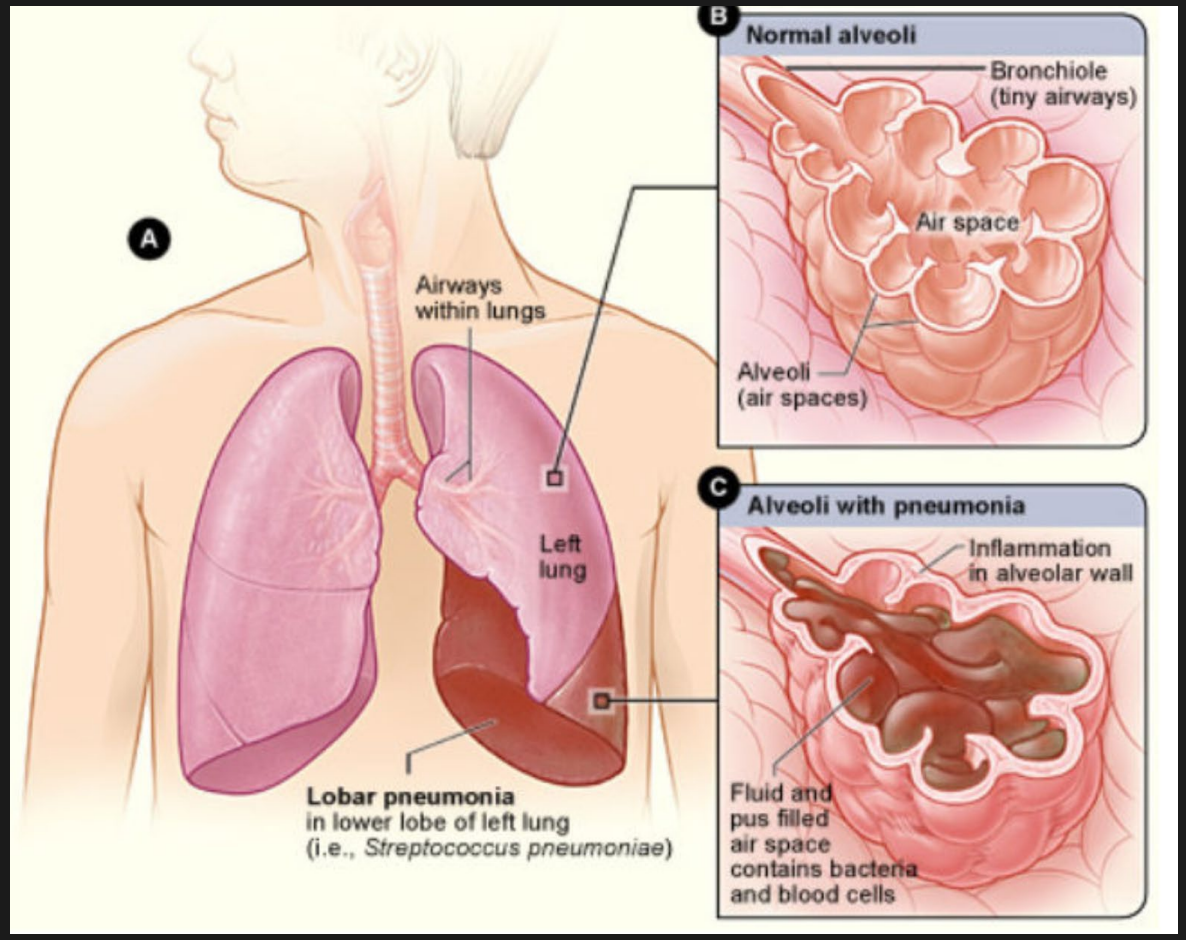
Pneumonia is the world's l ing infectious killer of c , claiming the lives of ian 800,000 chil der the age of five every year, more than 2,000 every day.

These deaths are preventable

Unicef, 2019

What is Childhood Pneumonia?

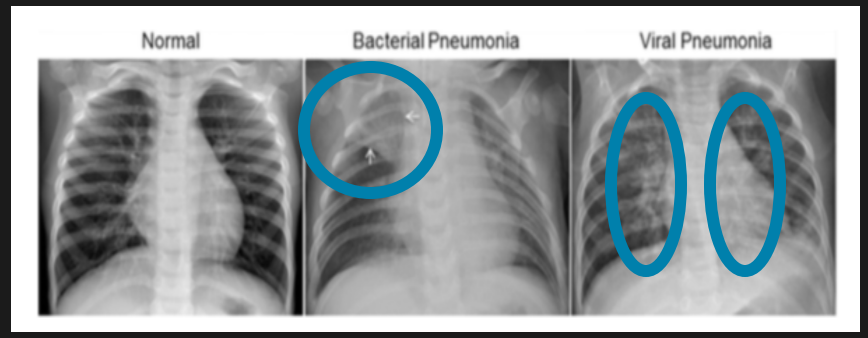
- Pneumonia is an infection in the lungs
- The airsacs (alveoli) fill with fluid and pus making breathing difficult, or painful
- Most often caused by bacteria, viruses or fungi.
- Bacterial pneumonia must be treated timely with antibiotics
- This project uses neural networks to classify whether an chest x-ray of a sick child indicates pneumonia (either bacterial or viral)



Childhood Pneumonia JAMA. 2017;318(5):490. doi:10.1001/jama.2017.9428

Business Objective: To Improve Treatment through Faster and More Accurate Diagnosis

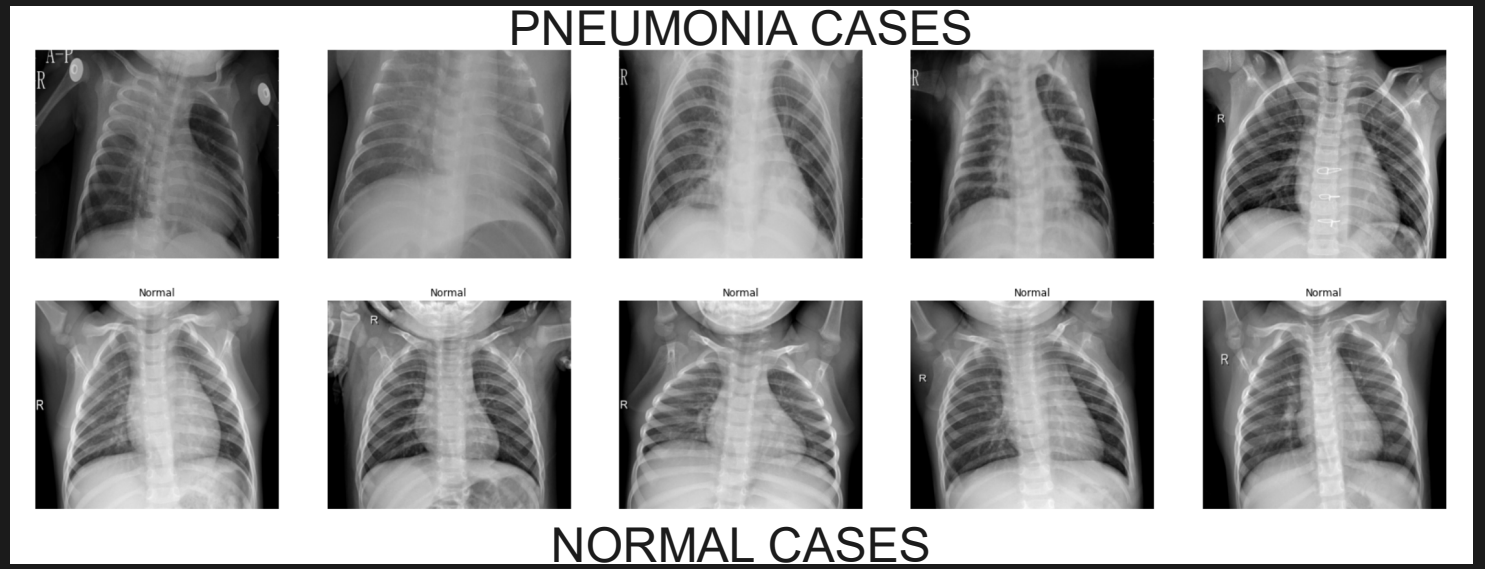
- Reading chest x-rays requires significant skill.
- Comparisons to human reading of charts shows a large variation in skill
- Childhood pneumonia is most prevalent in countries with limited numbers of skilled personnel to read chest xrays accurately. Delays in diagnosis are critical.

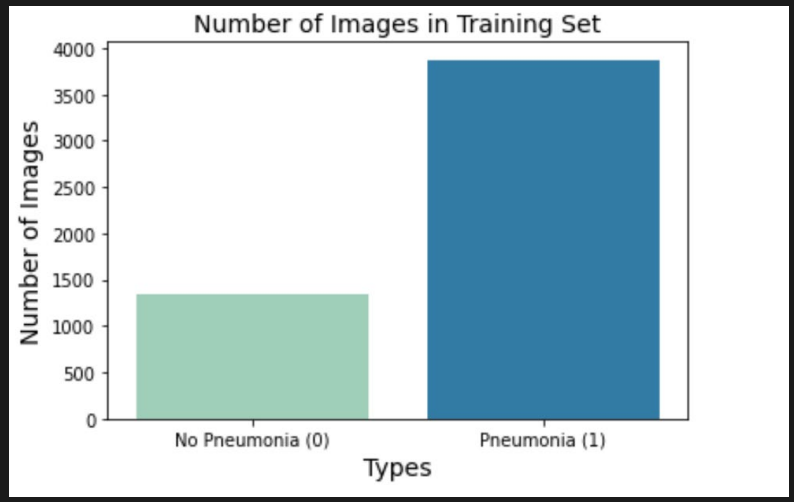


Weighted Error Comparison between human experts and model (Diabetic Retinopathy Imaging)

Description of the Dataset

- Chest X-ray images of children 1-5 years old
- Guangzhou Women and Children's Medical Center, Guangzhou, China
- All radiographs screened for poor imaging quality.
- The diagnoses were graded by two expert physicians. The testset was also checked by a third expert.

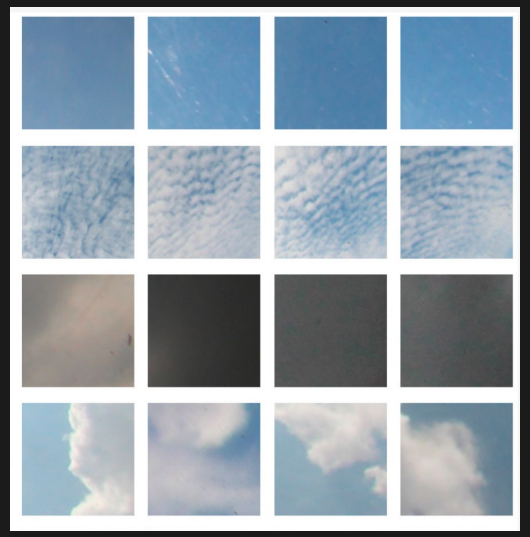


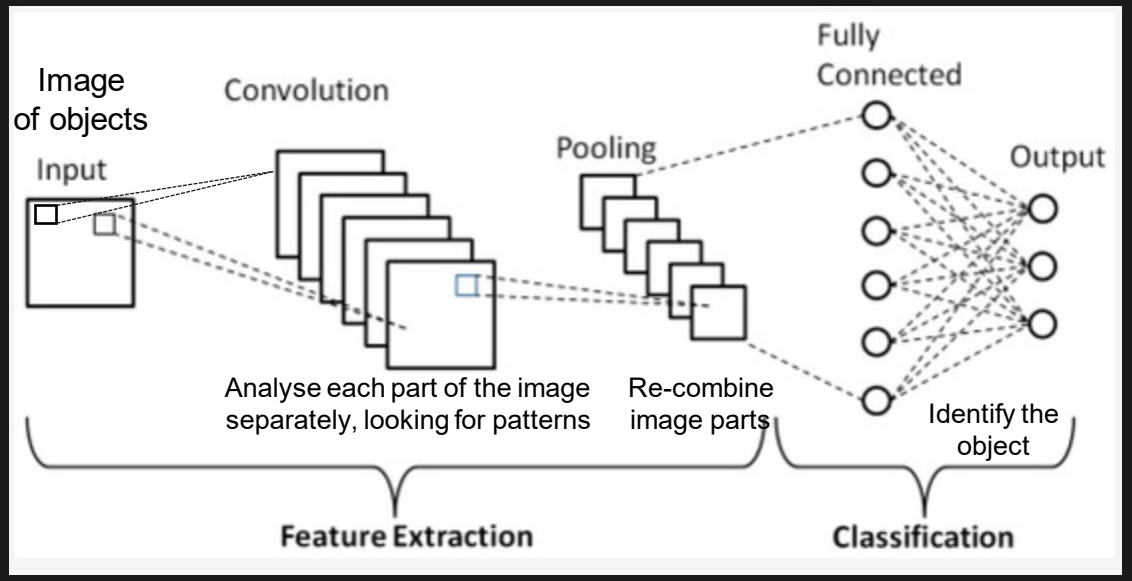


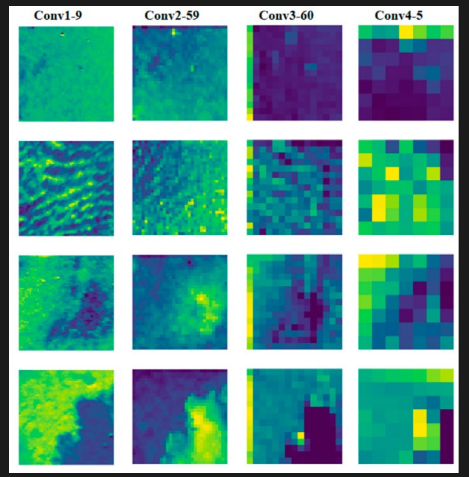
Methods Used – Convolutional Neural Networks

A unique branch of Deep Learning specifically towards image classification

Inputs





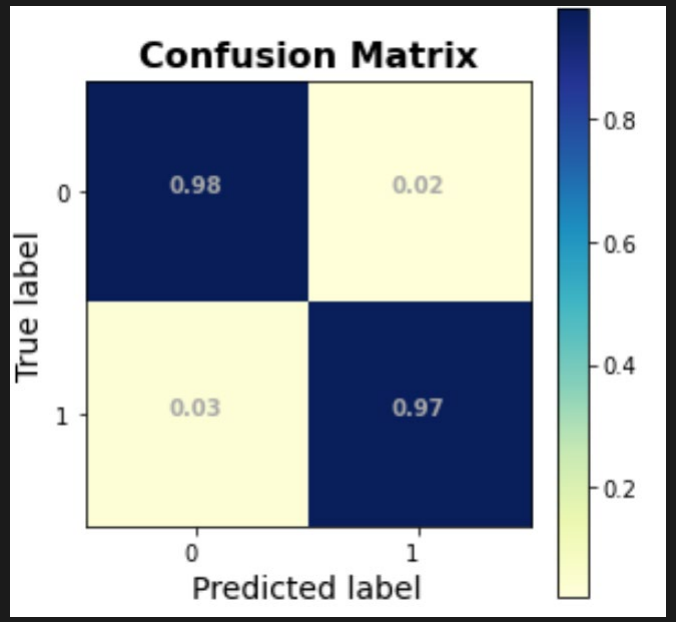


Identify type of cloud:

- Clear Sky (no cloud)
- Patterned clouds
- Thick dark cloud
- Thick white cloud

Phung, V.H.; Rhee, E.J. A High-Accuracy Model Average Ensemble of Convolutional Neural Networks for Classification of Cloud Image Patches on Small Datasets. *Appl. Sci.* **2019**, *9*, 4500.

Results – Potential for More Accurate Classification Models



1 = has pneumonia
0 = doesn't have pneumonia

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*******************************************************
        CLASSIFICATION REPORT:
*******************************************************
              precision    recall  f1-score   support

           0       0.91      0.98      0.94       134
           1       0.99      0.97      0.98       388

    accuracy                           0.97       522
```

- Accuracy of 97% on limited sample data
- Conclusion: There is a high potential for a higher accuracy diagnostic models for chest-xrays of childhood pneumonia

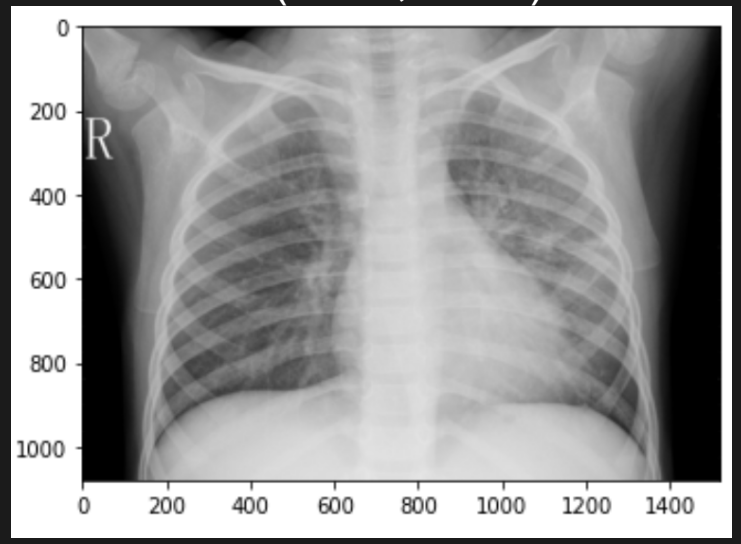
Recommendation - 1

- Use Deep Learning Models to aid health care workers, either as a Pre-screening tool, or as 2nd opinion.
  - Freeing up valuable medical resource time, while improving diagnostic accuracy
  - Remote diagnosis, especially in regions where there are few skilled technicians to read the x-rays, to speed diagnosis

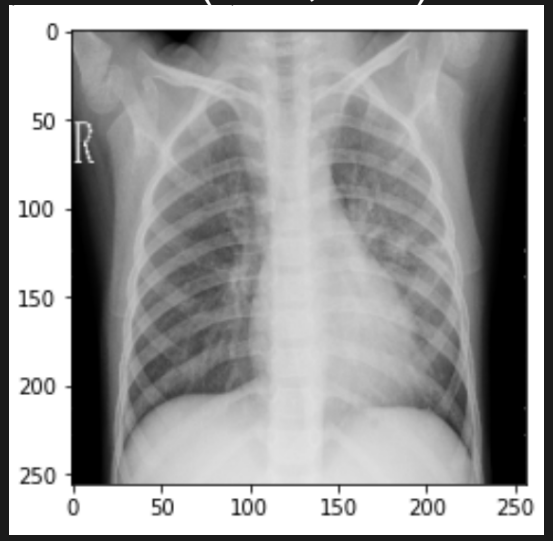
Recommendations – 2 & 3

2. Try lower resolution images (32,32) or (64,64) for models. Deep learning models are surprisingly good at classification at lower resolution (than usually what humans can do).
   - This may be a good way to approximate the effect of older, lower resolution x-ray machines, which more impoverished parts of the world
3. Convolutional Neural Networks work best – choose 2-5 convolutional layers, batch sizes 32-64, with a metric of val_accuracy. Since metrics are collected after each epoch, choosing smaller step size and more epochs enables one to hone in on the best model more easily.

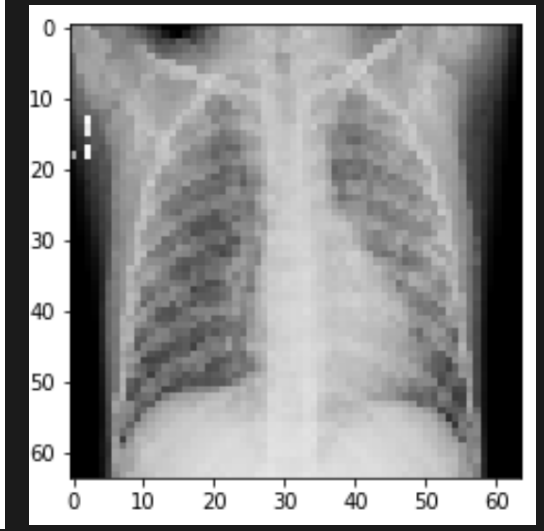
(1080, 1520)



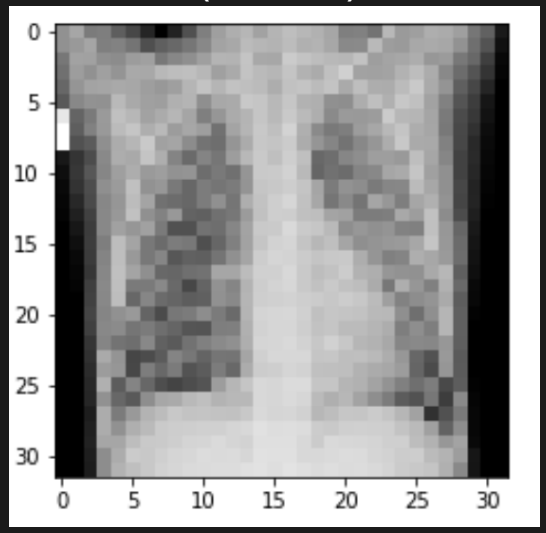
(256 , 256)



(64 , 64)



(32 ,32)



Future Directions

Clearly Deep Learning CNNs are powerful tools for fast and accurate image classification

In the case of medical imaging, the use cases are many, and may provide long-lasting societal benefits to detect and eliminate disease.

Future directions: Deployment of an application that can be used by health care professionals in the field requires a few more steps such as:

- Model Improvements
  - Generalize the model to diagnose bacterial and viral pneumonia with high accuracy. Since bacterial pneumonia requires immediate antibiotic treatments, this is a priority
  - Perform Image Augmentation on the dataset to increase model accuracy and stability
- Validation with other childhood pneumonia chest-xray data
  - Check the true positive recall and accuracy with other independent source of data
- Application in the field
  - Images may vary based on x-ray machine type and capability. Build a trained model to handle a variety of inputs.
  - Another option is to build a self-learning system which tunes specifically to a particular medical clinic and machine type.

Questions?

Thank You

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