Machine Learning Solution to Improve Care Management for Pneumonia

Samuel C. Kaspar
7th Grade,
John Adams Middle School, Rochester MN

Current Situation

- **Diagnosing pneumonia & notifying is slow**
- **Process involves disconnected systems & people**
- **About 2 million pneumonia patients die every year**

- **Issues caused : provider stress, low productivity, inaccurate results, & delayed care, which leads to poor patient outcomes**

So how can I get pneumonia scan results faster and more accurate?

Engineering Goal

Create an automated cloud solution to detect pneumonia using Machine Learning, store results, and finally, notify doctors and patients about the patient's health to provide better care

Procedures

*Procedures done in AWS**

Develop

1. Create a development environment
2. Create storage locations in the cloud to store images
3. Create Machine Learning (ML) model to detect pneumonia
4. Orchestrate image processing and notifications

Deploy

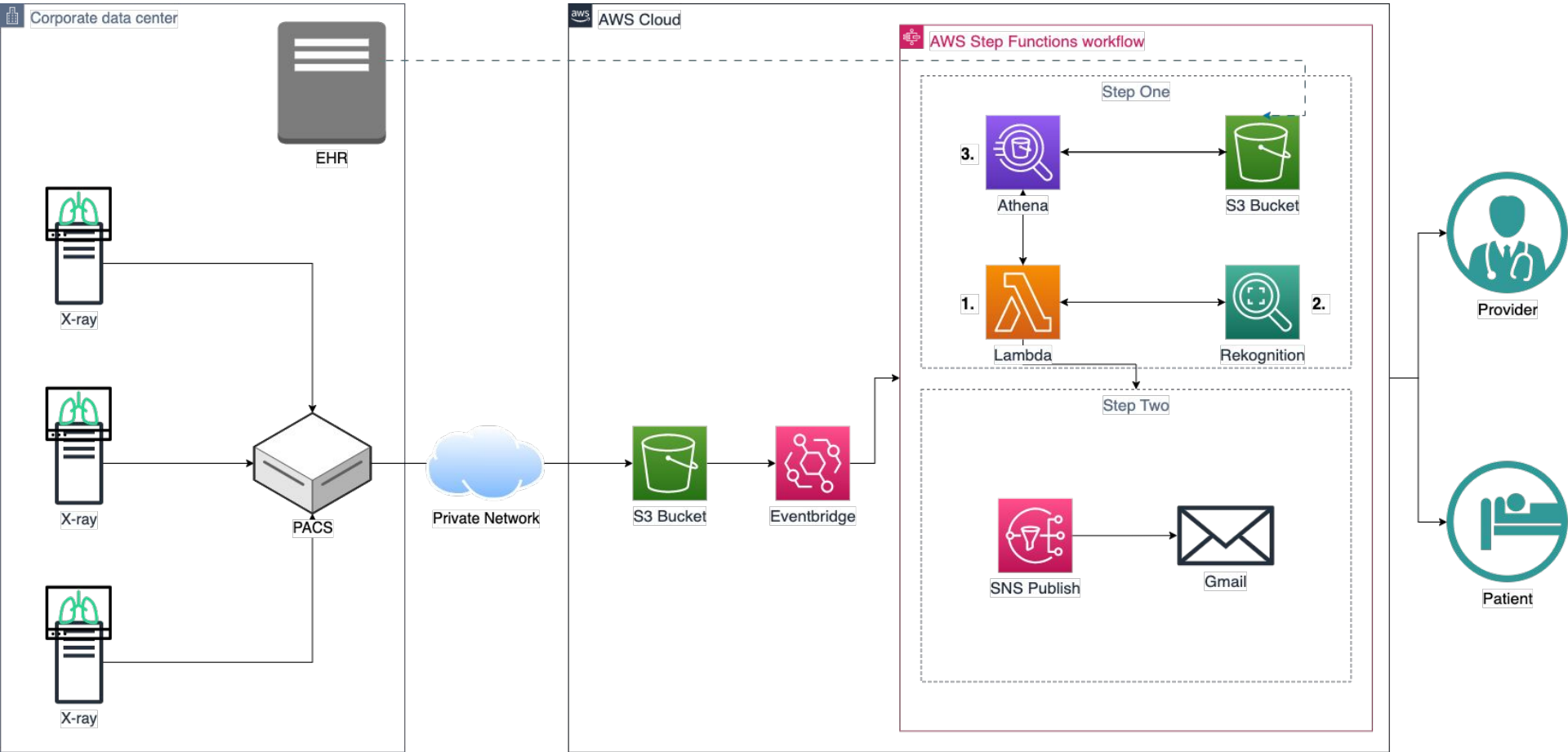
1. Compile and Deploy the solution on AWS*
2. Upload patient and provider info from EHR** to AWS
3. Send DICOM*** images with/without Pneumonia from past patients to ML model to train
4. Connect imaging system to push images to storage

Operate

1. Technician takes a scan using imaging equipment
2. Upload images to storage to simulate imports from PACS****
3. Patients & Providers receives notification

*Amazon Web Services, **Electronic Health Record, ***Digital Imaging and Communications in Medicine, ****Picture Archiving and Communication System

Architecture



Results -

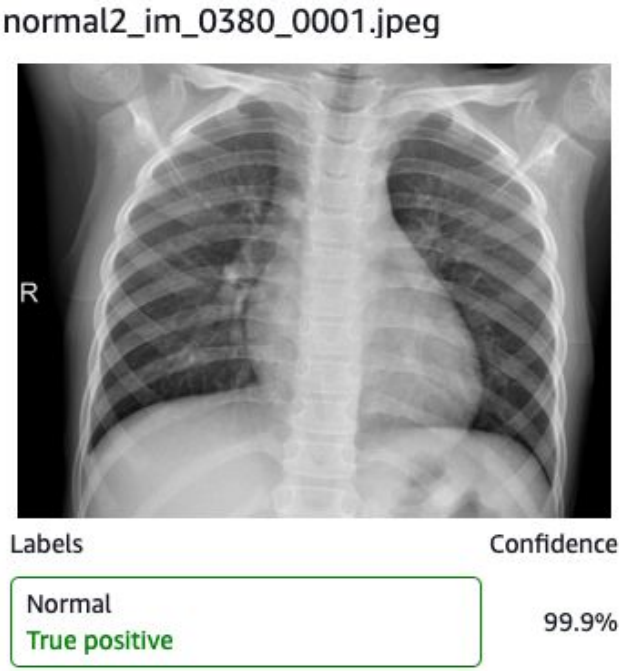
- **Fastest result was 7.18** seconds and the average out of 20 executions was 7.43 seconds.
- Will **improve** radiologists' and doctors' **productivity** by helping them focus on patients who have a higher potential for pneumonia.
- Can give **reliable results**, & reduce stress on doctors.
- Will **minimize** lengthy patient **wait times**.

Trial	Speed(secs) -
Trial 1	7.334
Trial 2	7.33
Trial 3	7.375
Trial 4	7.288
Trial 5	7.947
Trial 6	7.404
Trial 7	7.371
Trial 8	7.49
Trial 9	7.177
Trial 10	7.555
Average	**7.427**
Best	**7.177**

Cost for 10,000 Images per month

Infrastructure - **93$**

ML model - about **706$**



^ Cropped screenshot taken by Samuel Kaspar ^

https://www.kaggle.com/datasets/paultimothymooney/chest-xray-pneumonia

Conclusion

- This **solution is much faster** than the “traditional method” of detecting and communicating results
- **Takes less than 8 seconds** to detect pneumonia, and model accuracy can be improved
- Can **improve care management** for pneumonia by significantly decreasing processing time
- This solution **can be expanded** to support other diseases as well

References

- AWS Docs - https://docs.aws.amazon.com/
- DICOM - https://www.dicomstandard.org/
- W3schools - https://www.w3schools.com/mysql/mysql_where.asp
- Python - tutorial - https://www.w3schools.com/python/default.asp
- Synthea - https://synthea.mitre.org/downloads
- Google Cloud Docs - https://cloud.google.com/docs
- Our World in Data - https://ourworldindata.org/pneumonia
- Mayo Clinic - https://www.mayoclinic.org/diseases-conditions/pneumonia/symptoms-causes/syc-20354204
- AWS Sample Solutions - https://aws.amazon.com/solutions/?awsm.page-solutions-whats-new=2
- TechTarget - https://www.techtarget.com/searchhealthit/definition/picture-archiving-and-communication-system-PACS
- Kaggle - https://www.kaggle.com/datasets/paultimothymooney/chest-xray-pneumonia

NOTE

Next Slides are for my Binder

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So how can I get pneumonia scan results faster and more accurate?

Engineering Goal

My goal is to create an automated cloud solution that can detect pneumonia using Machine Learning, store results, and finally, notify doctors and patients about the patient's health to provide better care

I hypothesized that my solution would deliver results in about *20 secs*

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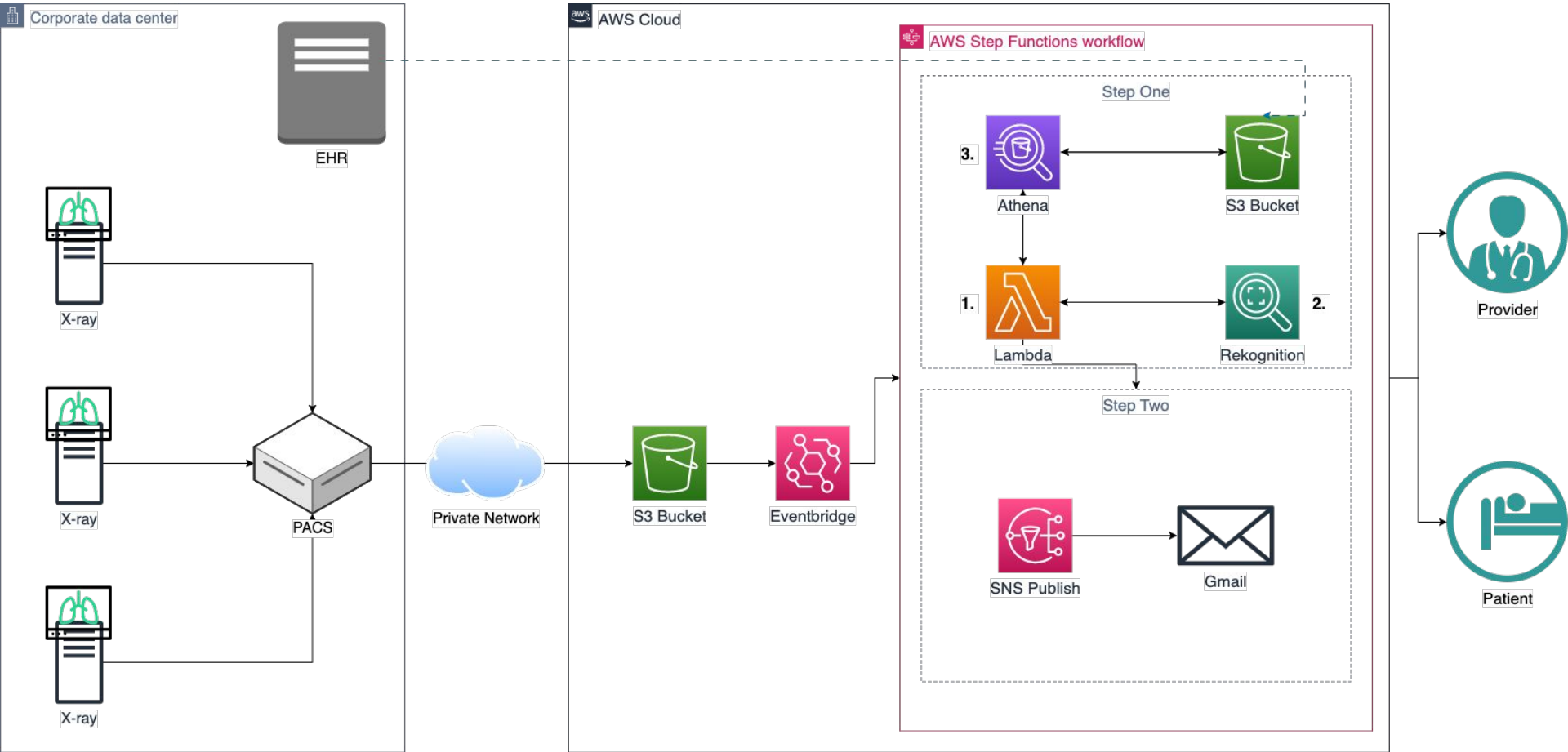

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normal2_im_0380_0001.jpeg

Labels Confidence

Normal
True positive

99.9%

^^ Cropped screenshot taken by me ^^

Expected Results

Detection and Notification got much faster than the “Traditional Method”

Unexpected Results

The solution was much harder to complete than what was envisioned, but was much much faster than imagined

Conclusion

I found out that my **solution is much faster** than the "traditional method" of detecting pneumonia, and communicating results. Now it **takes less than even 8 seconds** to detect pneumonia and the model accuracy can be improved by training with bigger datasets. This automated cloud solution can **improve care management** for pneumonia by significantly decreasing the processing time. This solution can be expanded to support other diseases as well.

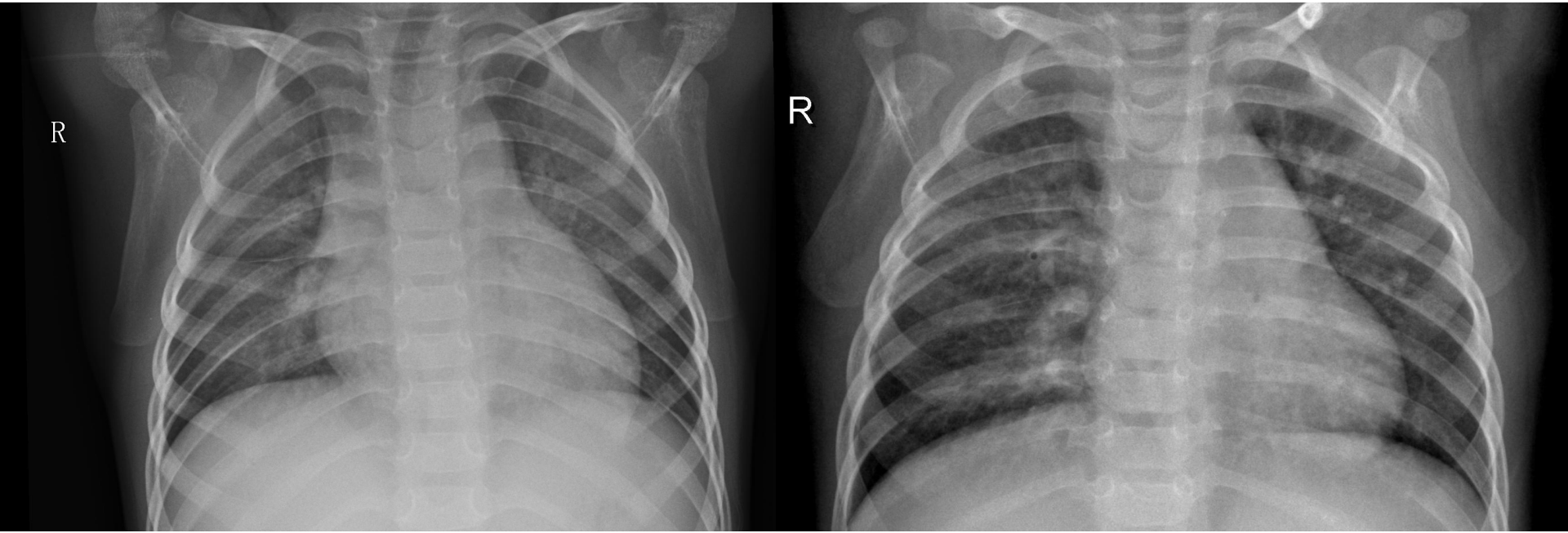
Next Steps

- Train ML model with larger data sets
- Expand model to support multiple diseases
- Reduce or eliminate inefficiencies in solution
- Send messages to providers also
- Create solution in Cloud9 using code

References

- AWS Docs - https://docs.aws.amazon.com/
- W3schools - https://www.w3schools.com/mysql/mysql_where.asp
- Python - tutorial - https://www.w3schools.com/python/default.asp
- Synthea - https://synthea.mitre.org/downloads
- Google Cloud Docs - https://cloud.google.com/docs
- Our World in Data - https://ourworldindata.org/pneumonia
- Mayo Clinic - https://www.mayoclinic.org/diseases-conditions/pneumonia/symptoms-causes/syc-20354204
- DICOM - https://www.dicomstandard.org/
- AWS Sample Solutions - https://aws.amazon.com/solutions/?awsm.page-solutions-whats-new=2
- TechTarget - https://www.techtarget.com/searchhealthit/definition/picture-archiving-and-communication-system-PACS
- Kaggle - https://www.kaggle.com/datasets/paultimothymooney/chest-xray-pneumonia

Images



^^ Images taken form Kaggle.com ^^

Custom Labels > Projects > xray > Models > xray.2022-12-29T15.48.03 > Performance

Evaluate image
Review the test results of your trained model for individual images. Below each image is information about the model's predicted label compared with the label assigned to the image in the test dataset, noted by result type. You can also filter by label and result types.

Filter by label

Choose labels
Choose labels to filter images

Select a label

- [ ] True positive
- [ ] False positive
- [ ] False negative

Images (17) Info

Search images by file name

1 2 3 ...

normal2_im_0381_0001.jpeg

Labels	Confidence
Normal True positive	92.4%
PNEUMONIA False positive	7.6%

normal2_im_0380_0001.jpeg

Labels	Confidence
Normal True positive	99.9%

Actual Screenshot Taken *by me* in the AWS Cloud Rekognition Console

Special Thanks

I would like to thank my dad, mom, and science teachers for helping me throughout this project