Pneumonia Detection from X-Ray

Group 5

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Product Concept/Overview

- Classification of Pneumonia is difficult [1]
  - No standard/widely accepted definition
  - Specific microbial cause remains unknown
- Currently a shortage of doctors [2]
  - Allows for clear-cut cases to be classified with our model

Normal

Pneumonia

[1] Mackenzie, Grant. "The definition and classification of pneumonia." Pneumonia 8.1 (2016): 1-5.
[2] Robeznieks Senior News Writer, Andis. “Amid Doctor Shortage, NPS and PAS Seemed like a Fix. Data's in: Nope.” American Medical Association, American Medical Association, 17 Mar. 2022, https://www.ama-assn.org/practice-management/scope-practice/amid-doctor-shortage-nps-and-pas-seemed-fix-data-s-nope.

Product AI Canvas

Opportunity

- Current doctor shortage
- Difficulty of classification

Consumers

- Hospitals
- Patients (self diagnosis)

Strategy

- Large initial dataset

Policy & Process

- Requires strict data security to satisfy HIPAA

Solution

- Instant image recognition and classification

Data

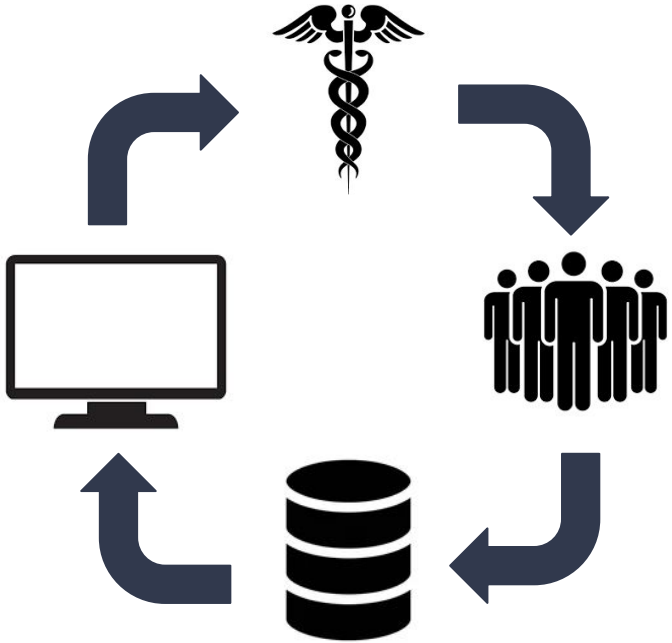
- Large open source datasets online
- Constant updates from hospital input

Success Criteria

- Improve diagnosis accuracy from doctors
- Model accuracy reaches a point where it can directly be used for diagnosis

Data Flywheel

1. The doctor identifies the possibility of pneumonia
2. A X-ray is taken
3. The X-ray is uploaded to the model database
4. The database makes a prediction and outputs it back to the doctor
5. The doctor reviews the result as part of diagnosis
6. The final result is obtained from the treatment
7. That result updates the model



CNN Model Design

Layer	Kernel Shape	Output Shape	Params	Mult-Adds
0_bn0	[3]	[1, 3, 227, 227]	6.0	3.0
1_conv1	[3, 64, 5, 5]	[1, 64, 75, 75]	4.864k	27.0M
2_bn1	[64]	[1, 64, 75, 75]	128.0	64.0
3_conv2	[64, 128, 3, 3]	[1, 128, 35, 35]	73.856k	90.3168M
4_bn2	[128]	[1, 128, 35, 35]	256.0	128.0
5_conv3	[128, 256, 3, 3]	[1, 256, 8, 8]	295.168k	18.874368M
6_bn3	[256]	[1, 256, 8, 8]	512.0	256.0
7_dropout1	-	[1, 256, 8, 8]	-	-
8_fc4	[16384, 2048]	[1, 2048]	33.55648M	33.554432M
9_fc5	[2048, 2]	[1, 2]	4.098k	4.096k

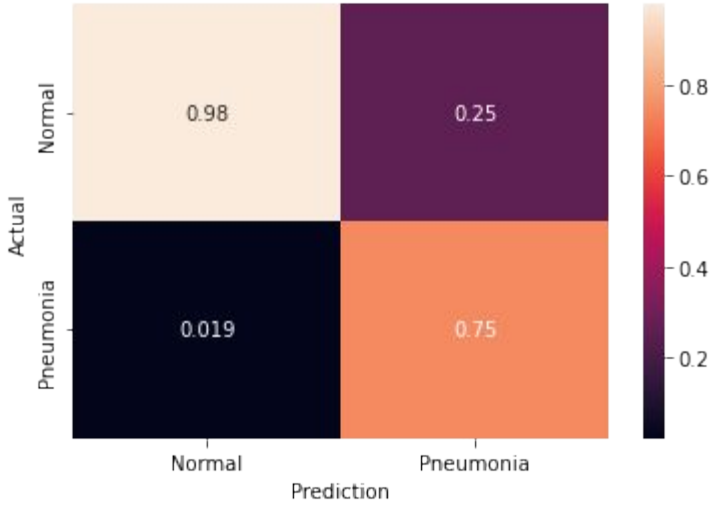
	Totals
Total params	33.935368M
Trainable params	33.935368M
Non-trainable params	0.0
Mult-Adds	169.750147M

- 3 convolutional layers
- Dropout
- 2 fully connected layers
- 2 classes for now
  - Room to scale
- 40 - 60s each epoch
  - Gtx 1080 ti
- 10 Epochs

Model Performance

- High Precision for Normal
- High recall for Pneumonia
- When the prediction is Normal,
- Only 2% are actually Pneumonia.
- Identify as many Pneumonia patients.
  - Low False Negative
  - Improve on False Positive

	precision	recall	f1-score	support
NORMAL	0.98	0.44	0.60	234
PNEUMONIA	0.75	0.99	0.85	390
accuracy			0.79	624
macro avg	0.86	0.72	0.73	624
weighted avg	0.83	0.79	0.76	624



MVP Development and Lessons Learned

- Simple image upload
- Initial prediction, doctor suggests further tests (eg. Pleural fluid culture or CT scan)
- Doctor provides feedback if the predictions were right of wrong
- Obtain new model performance metrics
- Can also be used for model monitoring process

A minimum viable product is a version of a product with just enough features to be usable by early customers who can then provide feedback for future product development. A focus on releasing an MVP means that developers potentially avoid lengthy and unnecessary work.

Customer

- Intended to be a tool for:
  - Larger hospitals with staffing issues or an influx of patients
  - Smaller imaging practices
  - Improvement and ease of diagnosis
- Initially would require expert review
- Eventually meant to transition to a direct diagnosis tool

Future Work

- Needs functionality for updating the final diagnosis for labeling
- Model should automatically update on set intervals to improve accuracy
- Framework could eventually be updated to predict other conditions diagnosed via X-ray

Demo: https://44657.gradio.app/