Chest X-Ray Images for Pneumonia Classification

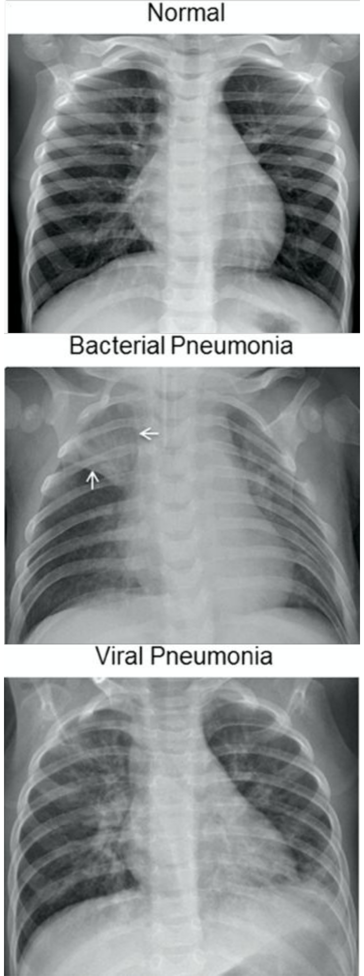
By Yuyue Zhou and Isabel Zhou

Motivation & Related Work

- Covid-19
- Chest X ray: critical to pneumonia detection (*Lynch, 2010*)
- Previous study : (*Kermany, 2018*)

Task	Test Acc	Test AUROC
Normal vs Pneu	0.928	0.968
Bacterial vs Viral	0.907	0.940

- Our goal: to improve different CNN model performances and extend to 3-class classification



Data

- From retrospective cohorts of 1 to 5 years old children (*Kermany, 2018*)
- Original dataset: contains training set and testing test only
- Our split based on patient:

		Training	Validation	Testing
Normal		1349	120	114
Pneumonia	Virus	1345	80	68
	Bacteria	2538	114	128

Evaluation Metrics

- F1: precision and recall, important in medicine
- AUROC: good for imbalanced data and has all threshold levels of F scores
- Accuracy

Methods

- Trained models and performed hyperparameter tuning on 2 and 3 classes classification ResNet152 *(He, 2016)*, Densenet161 *(Huang, 2017)*, GoogLeNet *(Szegedy, 2015)* Learning rate = 0.001, optimizer = Adam
- Evaluate on validation and deploy on the test set
- Classification activation map

Task: Normal/Pneu.

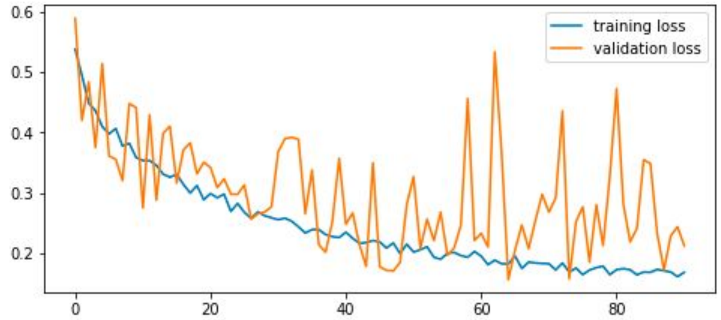
Results and Discussion

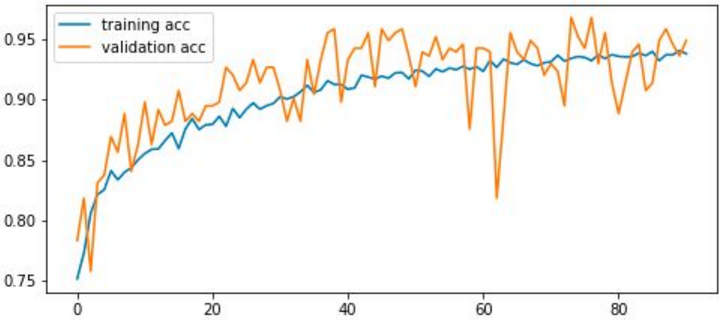
Model	Val Acc	Val AUROC	Val F1	Comments
ResNet152	0.962	0.956	0.969	178 epochs, 24+ hours. too long!
DenseNet161	0.965	0.957	0.972	198 epochs, 24+ hours. too long!
GoogLeNet	0.968	0.965	0.974	74 epochs, less time-consuming

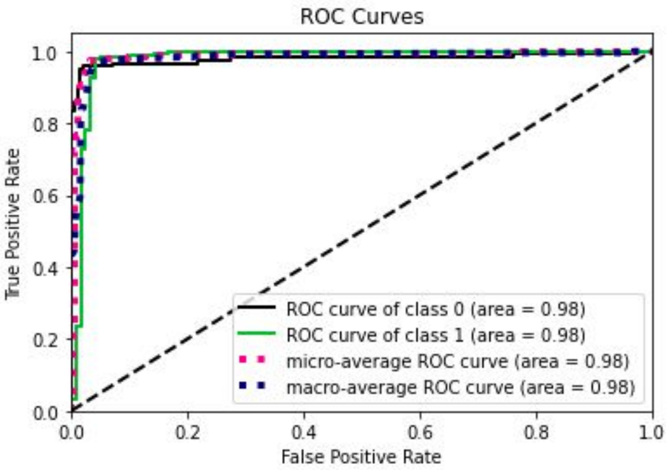
Performance and Time Efficiency: GoogLeNet.
ResNet and DenseNet each has more than 400 parameters, where GoogleNet has less than 200.

Best model: GoogLeNet, Task: Normal/Pneu.

Results and Discussion







Task: Normal/Virus/Bacteria

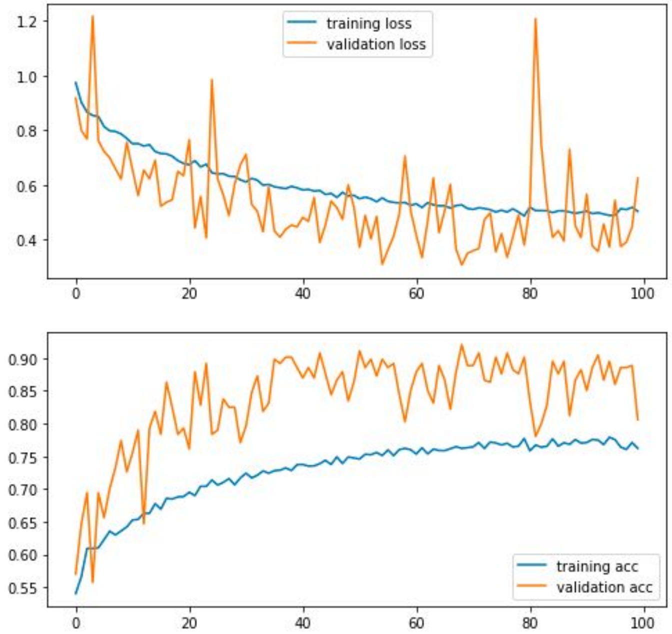
Results and Discussion

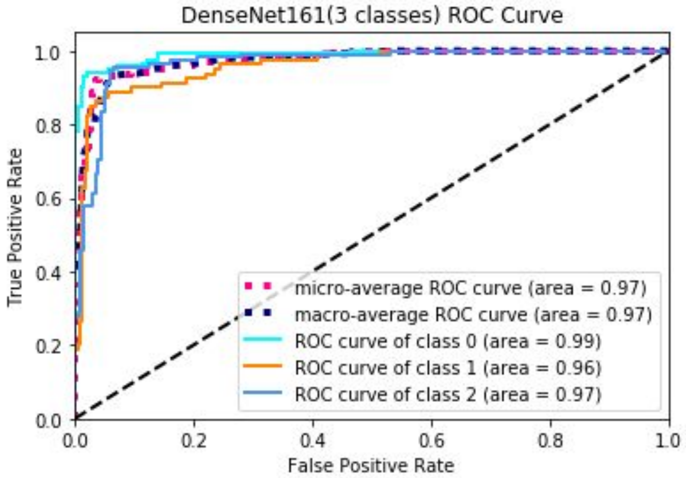
Model	Val Acc	Val Macro AUROC	Macro F1	Comments
ResNet152	0.892	0.965	0.883	96 epochs
DenseNet161	0.920	0.973	0.918	70 epochs
GoogLeNet	0.911	0.958	0.904	47 epochs, less time-consuming

Performance and Time Efficiency: GoogLeNet

Best model: DenseNet, Task: Normal/Virus/Bacteria

Results & Discussions

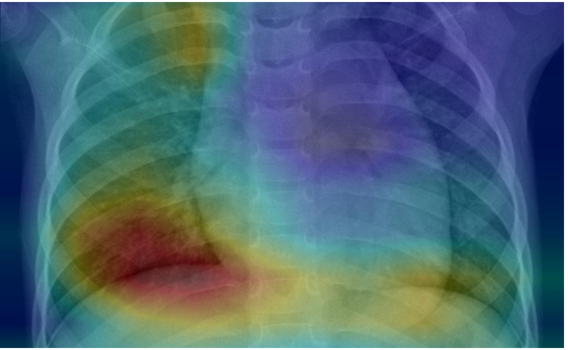




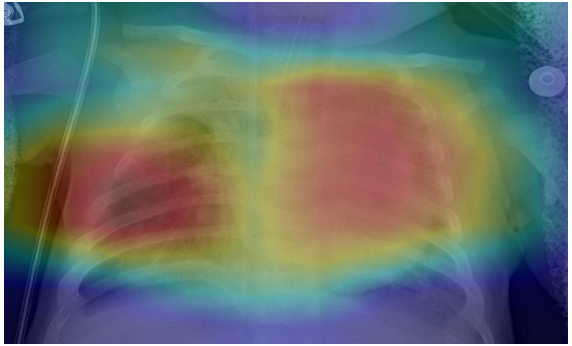
Best model: GoogleNet, Task: Normal/Pneu.

Final Results on Test Set

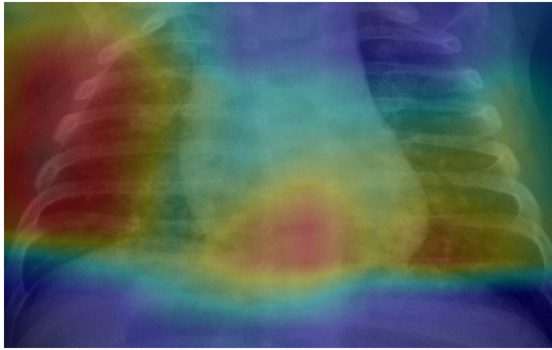
Macro Auc: 0.98 Acc: 0.932



Normal



Pneumonia (Bacteria)



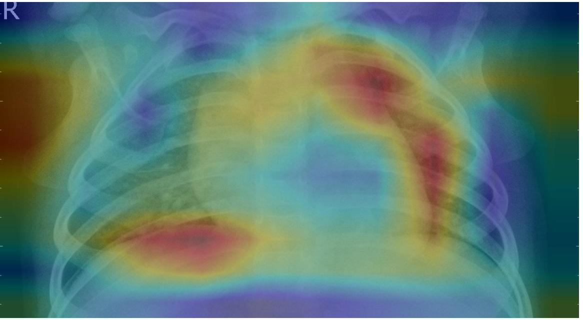
Pneumonia (Virus)

Discussion: slightly different from how doctor recognizes these pictures
Chest X-ray is not the only standard of pneumonia diagnosis. Physical exam and sputum culture should also be considered.

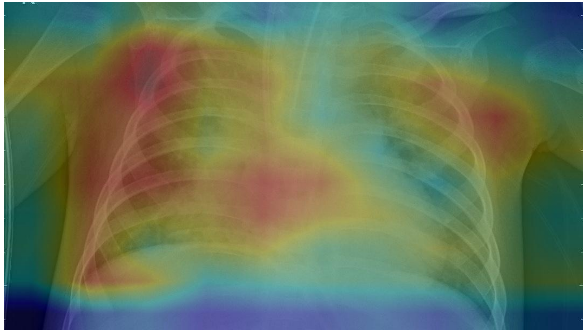
Best model: DenseNet, Task: Normal/Virus/Bacteria

Final Results on Test Set

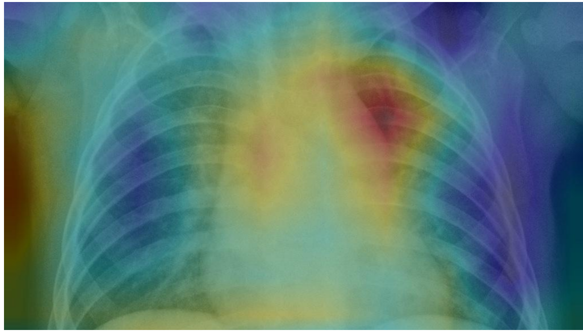
Macro Auc: 0.98   Acc: 0.913



Normal



Bacteria



Virus

Discussion: slightly different from how doctor recognizes these pictures
Chest X-ray is not the only standard of pneumonia diagnosis. Physical exam and sputum culture should also be considered.

Does Transform Learning Help?

Two-class:

Model	Val Acc	Val AUROC	Val F1	Comments
GoogLeNet	0.968	0.965	0.974	74 epochs, 12 hours+
Pre-trained GoogLeNet	0.971	0.969	0.977	73 epochs, < 10 hours

Three-class:

Model	Val Acc	Val Macro AUROC	Macro F1	Comments
GoogLeNet	0.911	0.958	0.904	47 epochs, ~ 12 hours
Pre-trained GoogLeNet	0.898	0.979	0.893	78 epochs, ~ 8 hours

Do we care more about performance or time efficiency?

Future work...

Chest X-ray images of pneumonia caused by fungi, parasites.

Covid-19 CT and chest X-ray images.

Evaluate how severe the disease is.

Combination of chest X-ray, physical exams and sputum culture.

Contributions

Yuyue Zhou: GoogLeNet, Research, split_data.ipynb, Hyperparameter tuning, Evaluate and test models

Isabel Zhou: ResNet152, DenseNet161, dataset.py, main.py, train_valid.py, visulization_results.ipynb, visulization_CAM.ipynb

Thanks to Lu Li: MD & PhD Candidate at Wuhan University, our medical advisor

References

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