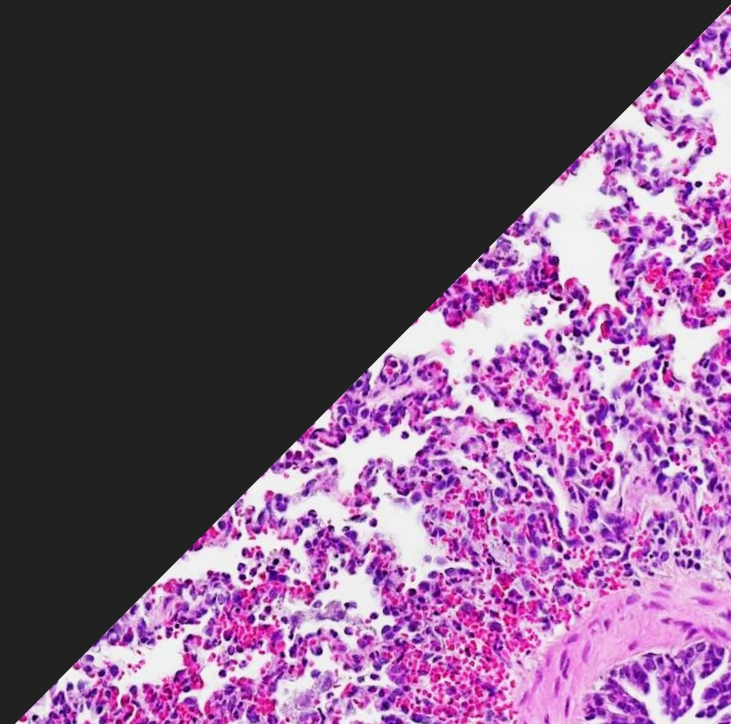


Detecting and Classifying Tissue Damage in Lungs of Covid-19 Patients Using Machine Learning

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EDAN70 – Project in Computer Science



Lung tissue damage

- Lung tissue damage from Covid-19 treatment
- Optimizing treatment combination and duration
- Analysis of histology images time consuming bottleneck



Image classification

- Medicine applications: alzheimer's detection, breast cancer detection
- Neural networks
- Image recognition models
- Transfer learning

Research Question and Target

Research question

How can classification granularity be improved for an image recognition model used to classify lung tissue damage?

Previous work

Binary classifier existed together with pipeline for data preparation

Target

- Analyze data labeling and investigate correlations
- Develop 3 label classifier model: low, medium, high
- Develop regression model

Method

Data preparation

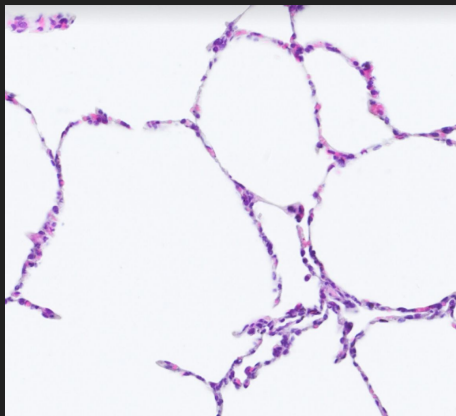
- Data exploration
- Labeling selection
- Pre-processing
- Data augmentation

Model development

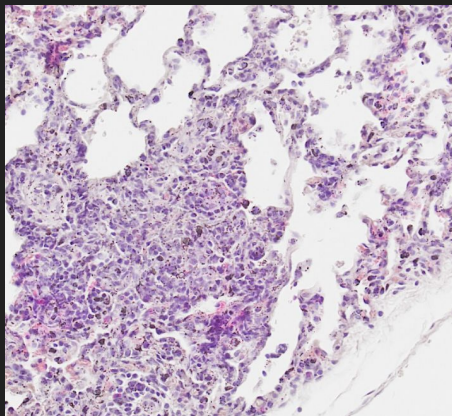
- Selection of model
- Classification
- Regression
- Training
- Evaluation

Data exploration

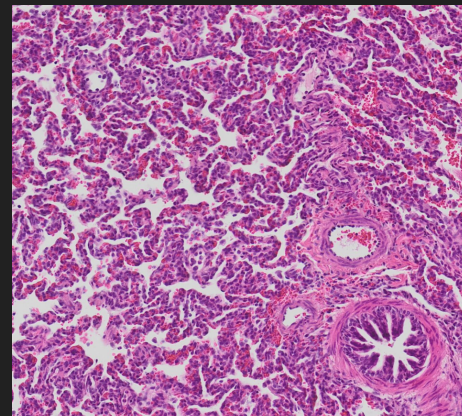
Low damage - 5.6



Medium damage - 19.6

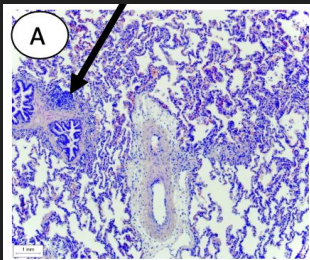


High damage - 45.8

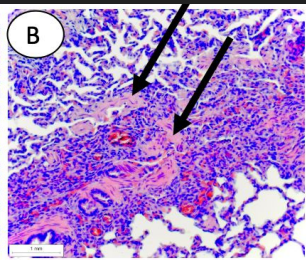


Feature label summary

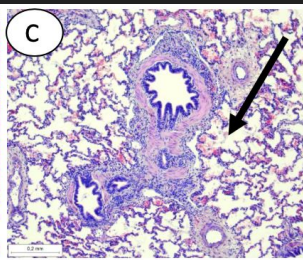
A - Inflammatory Cell



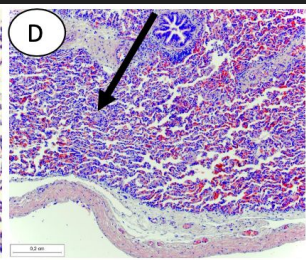
B - Hyaline membranes



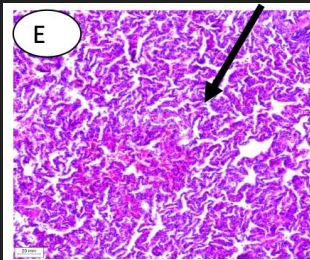
C - Proteinaceous debris



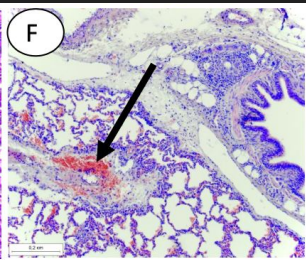
D - Thickening of alveolar wall



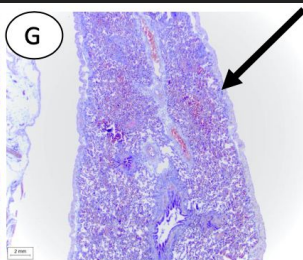
E - Enhanced injury



F - Hemorrhage



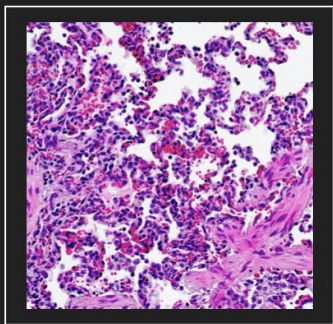
G - Atelectasis



Scoring

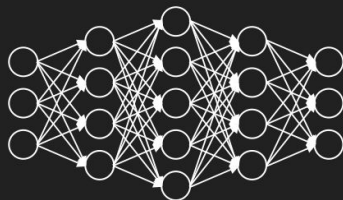
- Score range 0 (null) to 8 (strong) presence
- Sum of features is total score

Classification Model



Histology Image from pig

Treatment: ECMO 2 h



CNN Classifier
3 labels



Label predictions
Lung damage: High

Result

- 81 % average accuracy
- Mid-damage most difficult

Classification report – 3 fold average

	Precision	Recall	F1-score
Low	82%	94%	87%
Mid	73%	53%	61%
High	83%	87%	84%
Accuracy			81%

Result

Confusion matrices

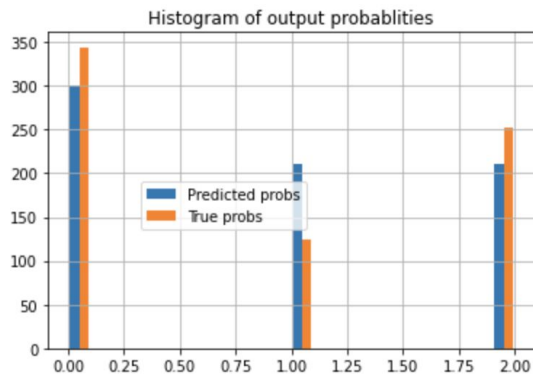
		Correct		
		Low	Mid	High
Prediction	Low	756	44	0
	Mid	161	262	87
	High	0	54	466
Total		917	360	553

		Correct		
		Low	Mid	High
Prediction	Low	82%	12,2%	0%
	Mid	18%	72,8%	16%
	High	0%	15,0%	84%

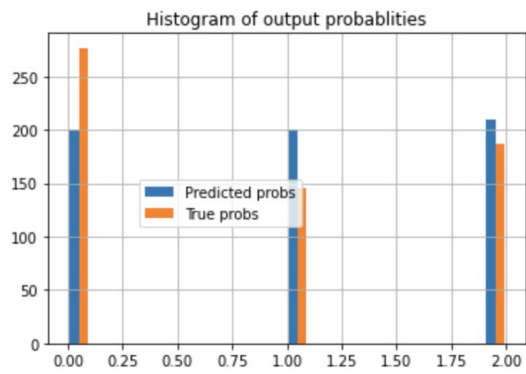
Result

Fold distribution and effect on accuracy

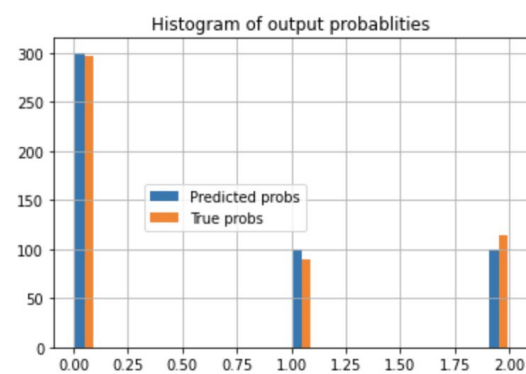
Fold 1



Fold 2

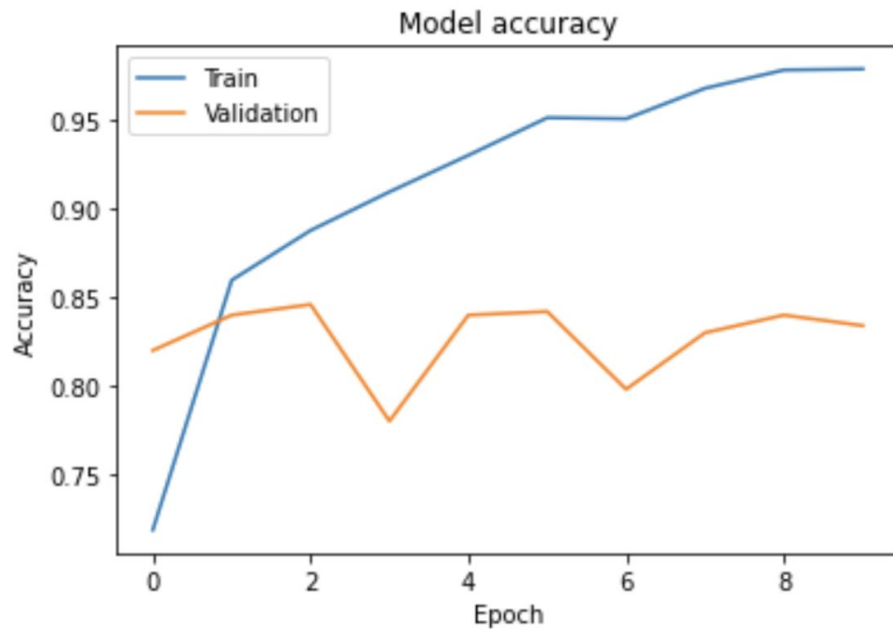


Fold 3



Result

Effects from transfer learning



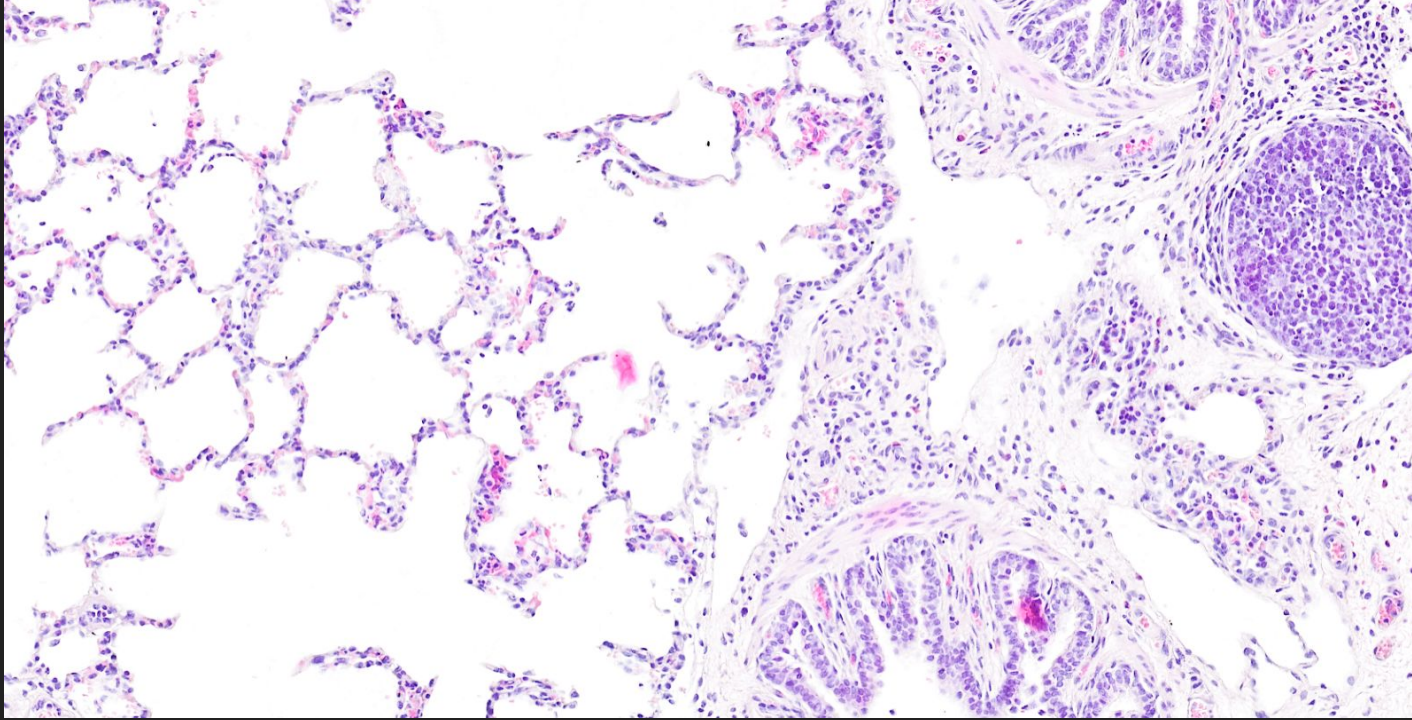
Potential

- Reduced reliance on human subjectiveness
- Improved development speed for Covid-19 treatment methods
- Lowered requirement for expertise in data handling
- Model structure generalizable for other medical imagery, laboratory work.

Challenges

- Small unbalanced data set
- Variance in data labeling
- Potential bias in data
- Model appropriateness

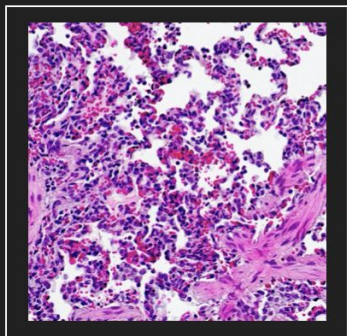
Difficult image



Future work

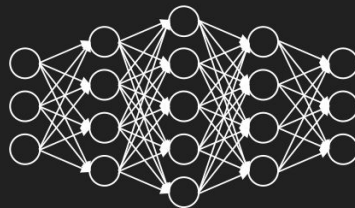
- Improving training dataset size and variance
- Increasing reliability in data labeling, possible?
- Increase number of labelers
- Show same image to same labeler multiple times
- Image generation using GANs
- Use model to gain insight for Covid-patients, other measurements?
- Deployment or similar models for medical application

Regression Model

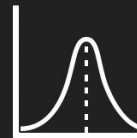


Histology Image from pig

Treatment: ECMO 2 h



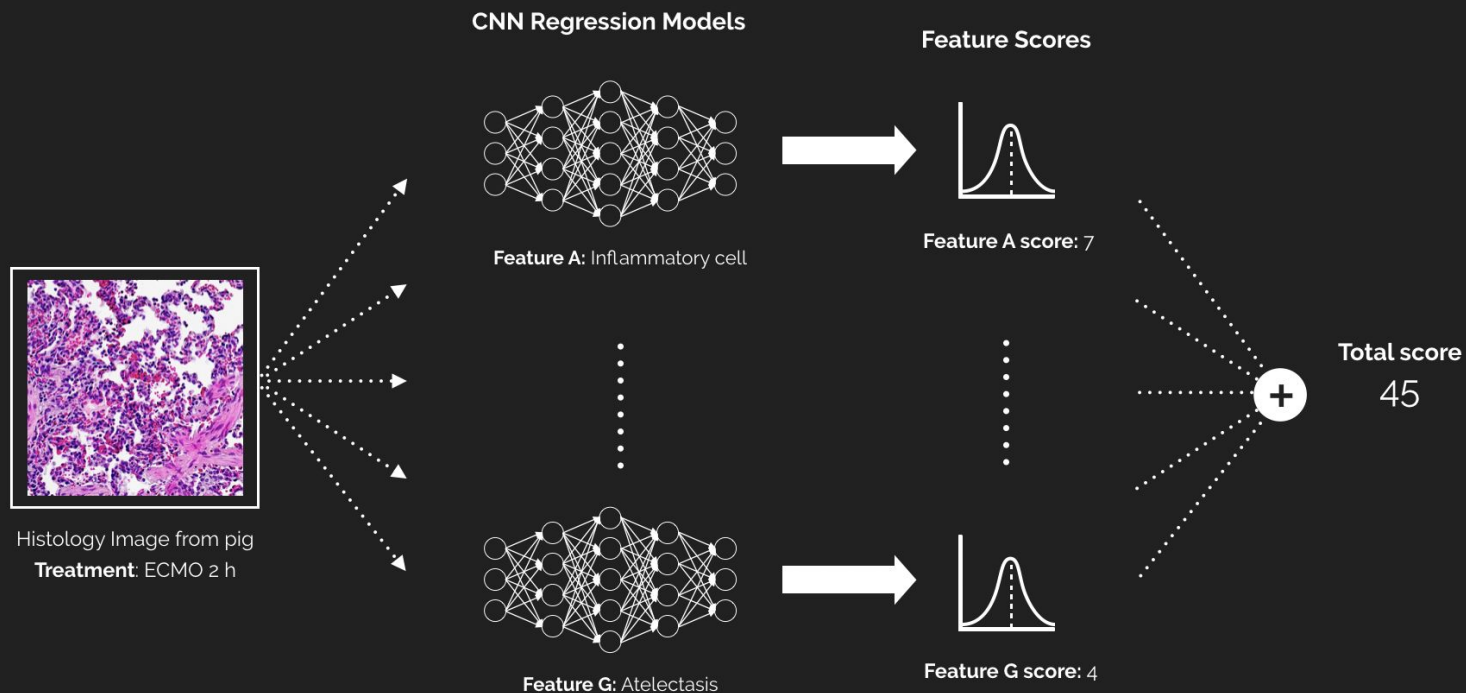
CNN Regression Model



Regression Score

Total score: 47.6

Multiple Feature Regression Models



Thank you!

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