Institute for Biostatistics and Informatics in Medicine and Ageing Research

Universität Rostock Traditio et Innovatio

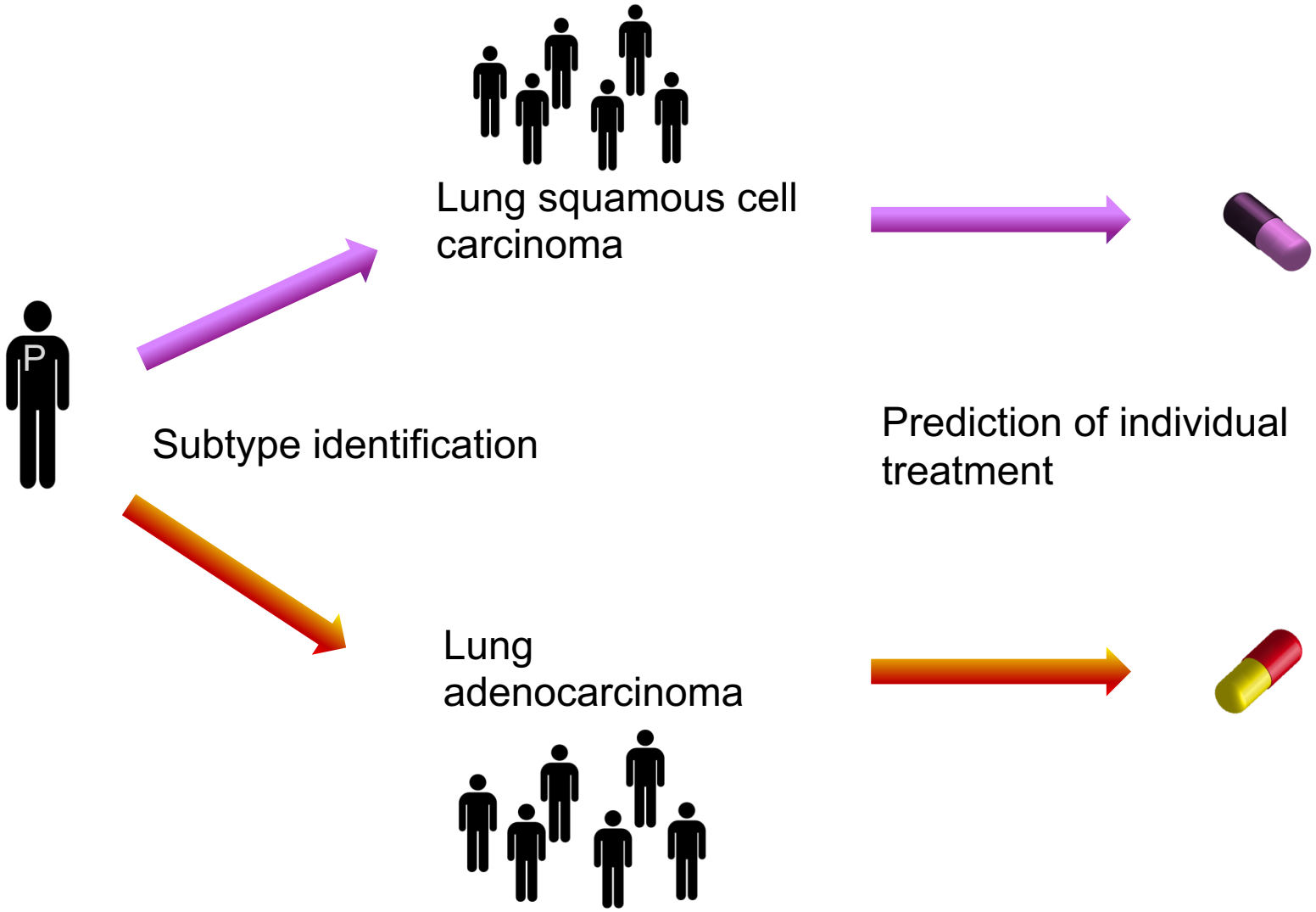
Universitätsmedizin Rostock

Deep Learning Hackathon
Final presentation to Lung-Radgen
Team : LUNG-SQUAD

presented by Sarah Fischer

Institute for Biostatistics and Informatics in Medicine and Ageing Research

Main idea


Lung squamous cell carcinoma
P
Subtype identification
Prediction of individual treatment
Lung adenocarcinoma

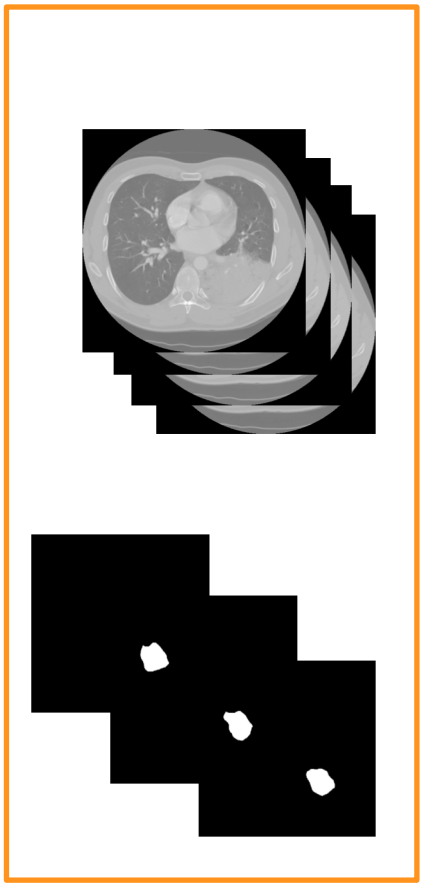
1. Image analysis

Patient Images:
- LUAD patients
- LUSC patients

Format :
- DICOM

Modality :
-CT scans

Segmentation
- Manually
- Tumor mask

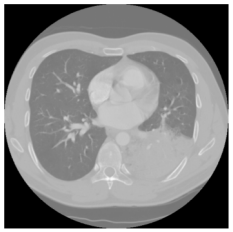


3D analysis

2D extension of the images space

1. Image analysis – Preprocessing

Interpolation to voxelsize 1mm^3
Cropped to 64*64*64



reading

[[0 0 0 ... 0 0 0] [0 0 0 ... 0 0 0]
[0 0 0 ... 0 0 0] ... [0 0 0 ... 0 0 0]
[0 0 0 ... 0 0 0] [0 0 0 ... 0 0 0]]

3D analysis

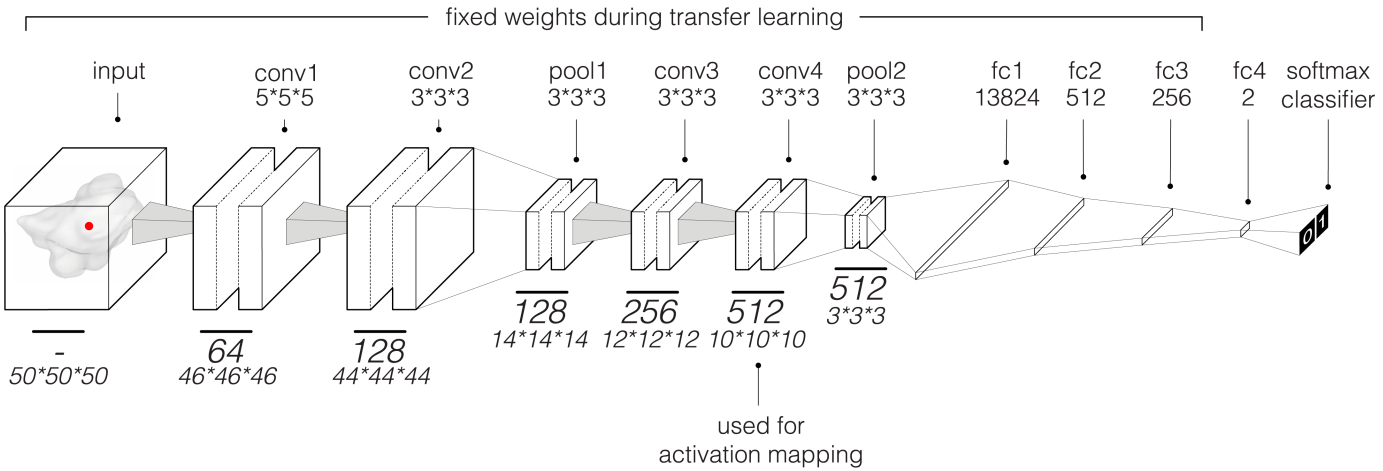
2D analysis

Extract CT slices with tumor in the mask

1. Image analysis – 3D analysis

Existing :
Deep learning for lung cancer prognostication::

- 3D convolutional network
- 2 year overall survival classification
- Based on CT images
- Input :
  - 50x50x 50 boundary box around the tumor
- Output: binary classifier



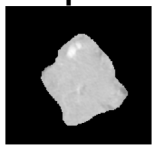
Source : Hosny, Ahmed, et al. "Deep learning for lung cancer prognostication: A retrospective multi-cohort radiomics study." *PLoS medicine* 15.11 (2018): e1002711.

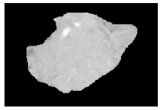
1. Applying the model on our data

Check the network for its generalisability:

- Check the survival for our dataset
  - Our dataset contains in total 21 patients with survival data
  - Extract the CT segments and downsize it from 64x64x64 to 50x50x50 (required input).
  - Accuracy : 43 %

input





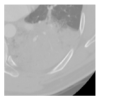
	precision	recall	f1-score	support
0	0.54	0.54	0.54	13
1	0.25	0.25	0.25	8
avg / total	0.43	0.43	0.43	21

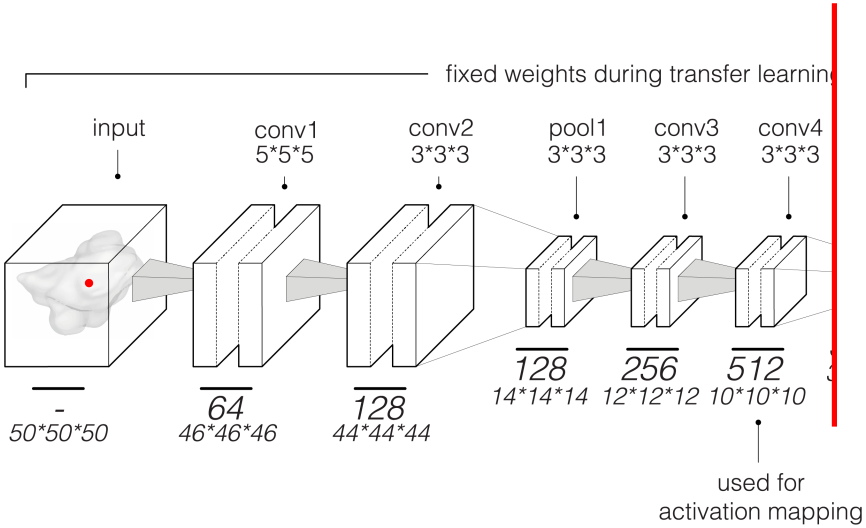
1. Transfer learning for 3D analysis

Transfer Learning to our LUAD and LUSC classification task

- Input size changed to 64x64x64
- Input is the CT crop

input



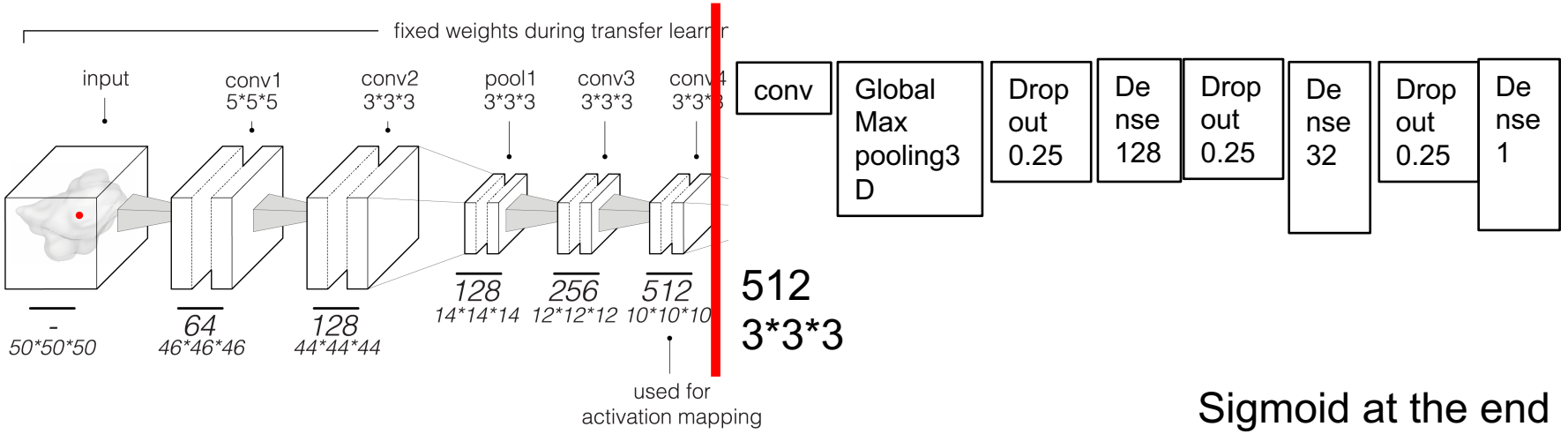


Source : Hosny, Ahmed, et al. "Deep learning for lung cancer prognostication: A retrospective multi-cohort radiomics study." *PLoS medicine* 15.11 (2018): e1002711.

1. Transfer learning for 3D analysis

Transfer Learning to our LUAD and LUSC classification task

- Remove everything after (and including) the last max pooling layers in the network.



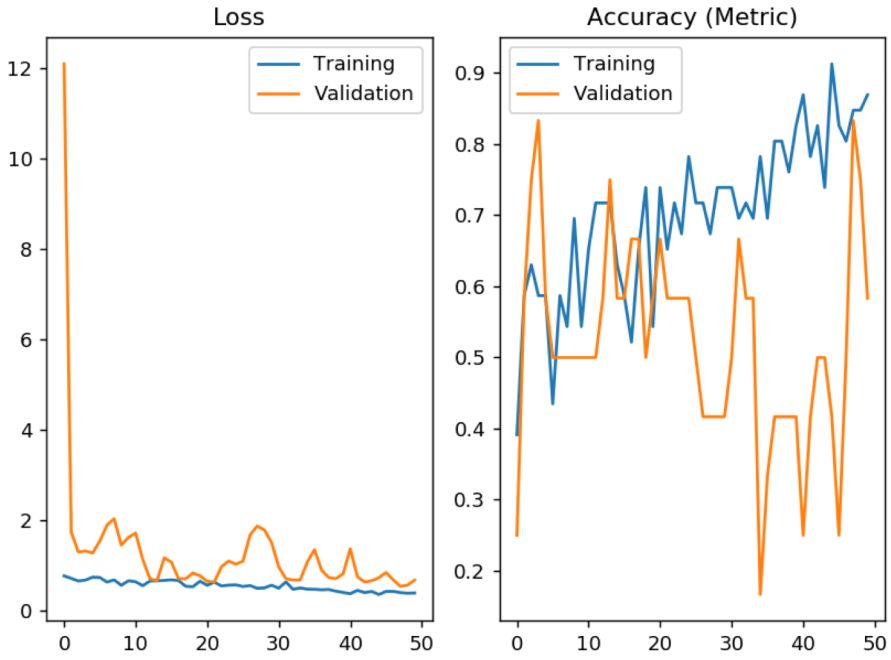
Sigmoid at the end

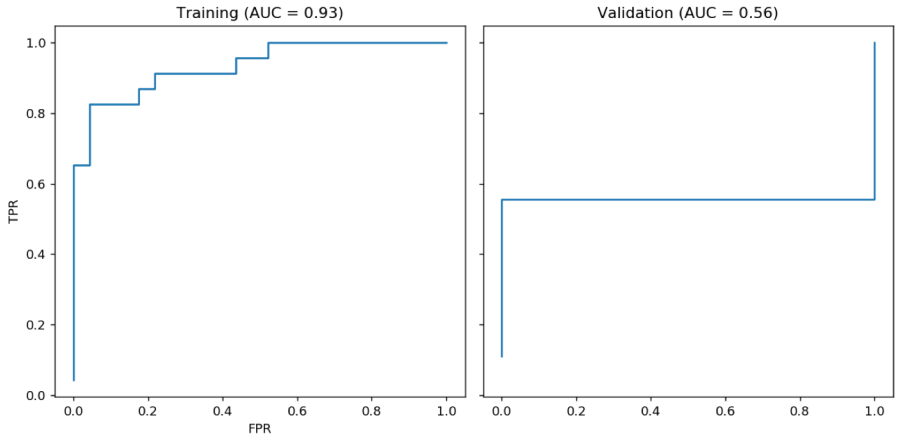
Source : Hosny, Ahmed, et al. "Deep learning for lung cancer prognostication: A retrospective multi-cohort radiomics study." *PLoS medicine* 15.11 (2018): e1002711.

1. Transfer learning for 3D analysis – preliminary results - limited HU and normalized

Training

	precision	recall	f1-score	support
0	0.90	0.78	0.84	23
1	0.81	0.91	0.86	23
avg / total	0.85	0.85	0.85	46





Validation

	precision	recall	f1-score	support
0	0.33	0.67	0.44	3
1	0.83	0.56	0.67	9
avg / total	0.71	0.58	0.61	12

1. Extension of the image sample space progressive generative adversarial networks

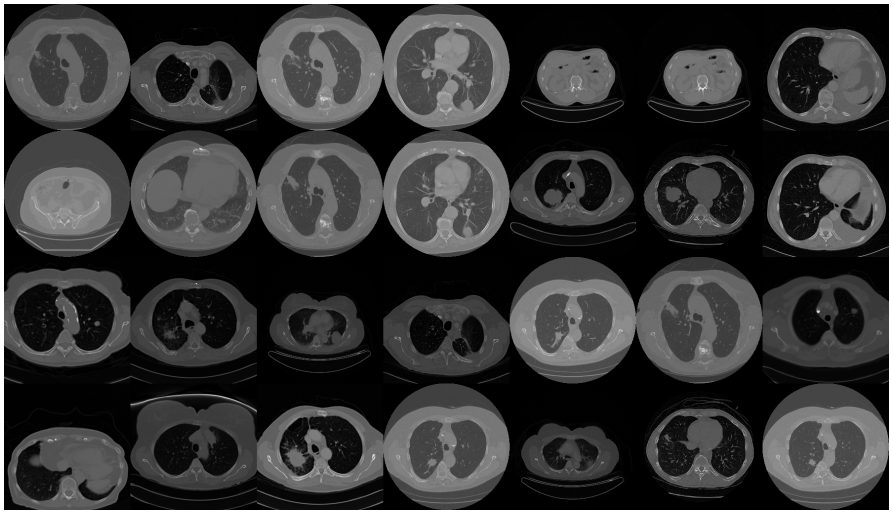
- Using an established progressive generative adversarial networks
- Trained the network on our dataset from scratch

Source: Karras, Tero, et al. "Progressive growing of gans for improved quality, stability, and variation." *arXiv preprint arXiv:1710.10196* (2017).

1. GAN output – CT after 14 h training

Fakes

Real



Challenge : Where is the tumor ?

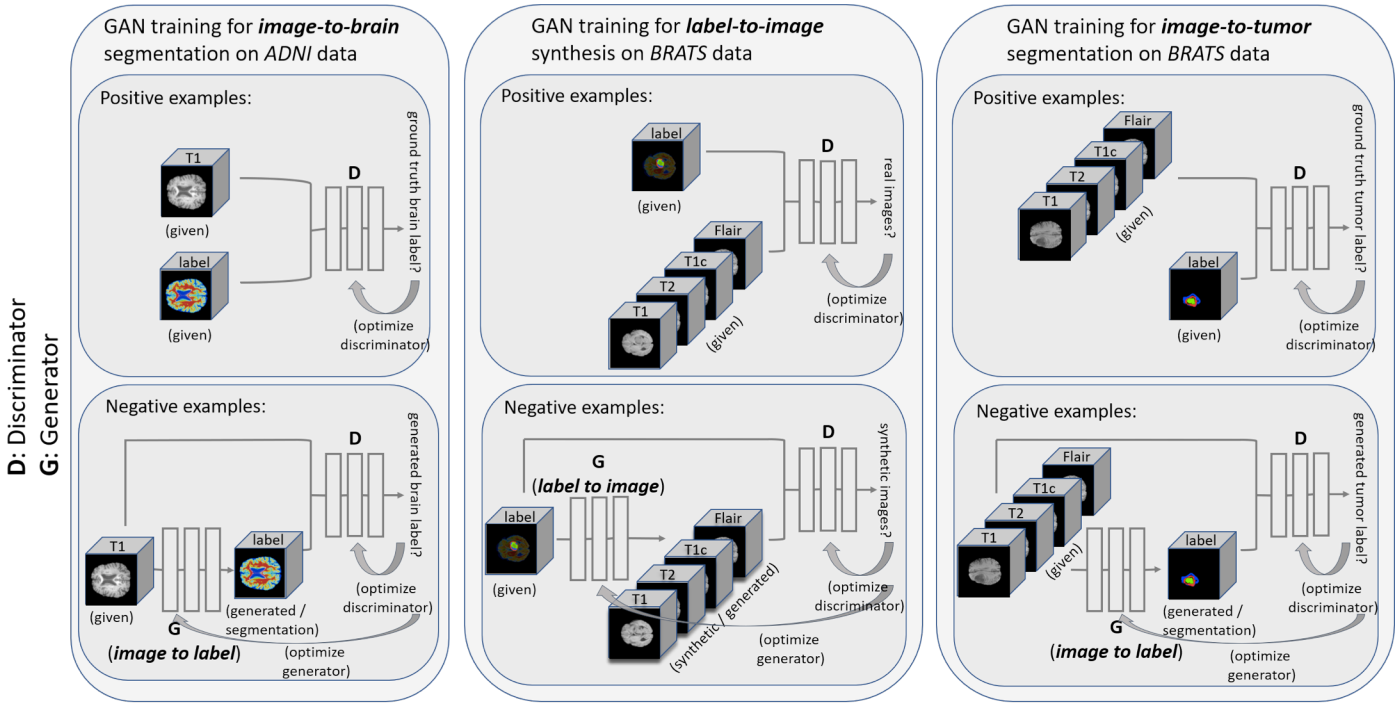
Network finds the tumor itself

Training network with CT and masks to detect masks

1. Image space extension – Further work Training network with CT and masks to detect masks

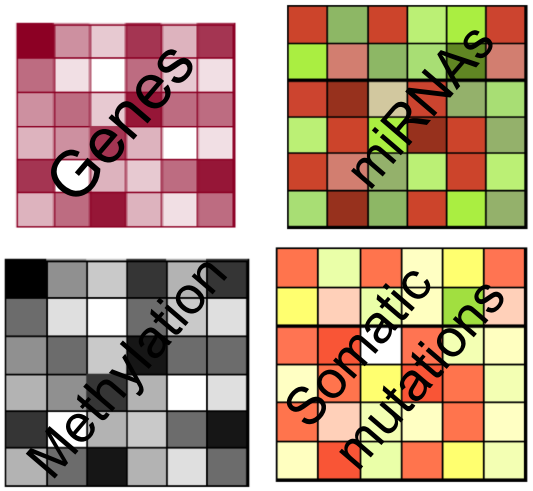
Shin et al. performed medical image synthesis for brain MRI's

Challenges: Adapt this to our CT scans

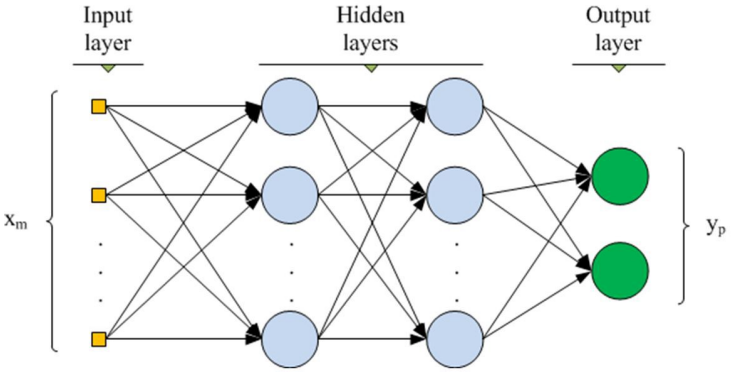


Source : Shin, Hoo-Chang, et al. "Medical image synthesis for data augmentation and anonymization using generative adversarial networks." *International Workshop on Simulation and Synthesis in Medical Imaging*. Springer, Cham, 2018.

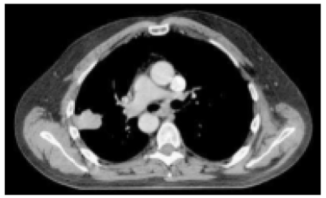
2. Classification of patients based on multiple datasets



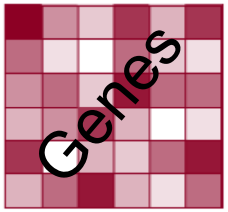
Integration

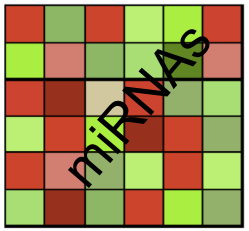


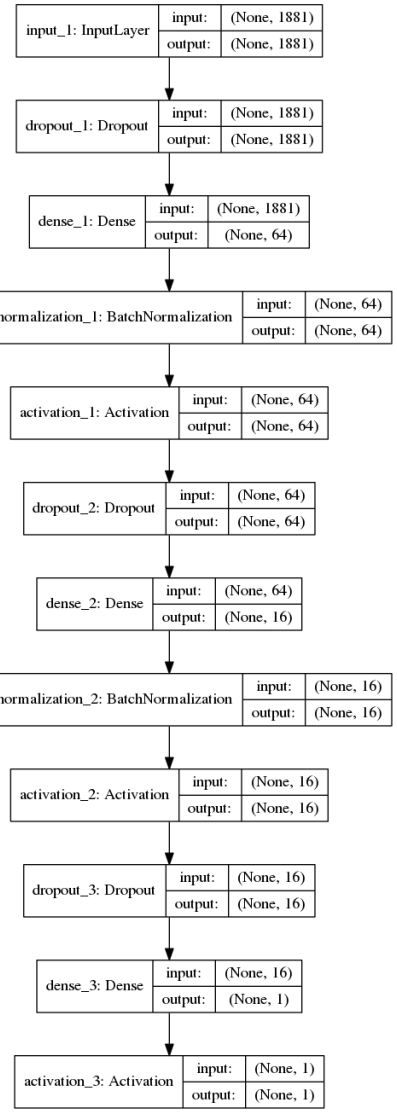
Original & newly generated images

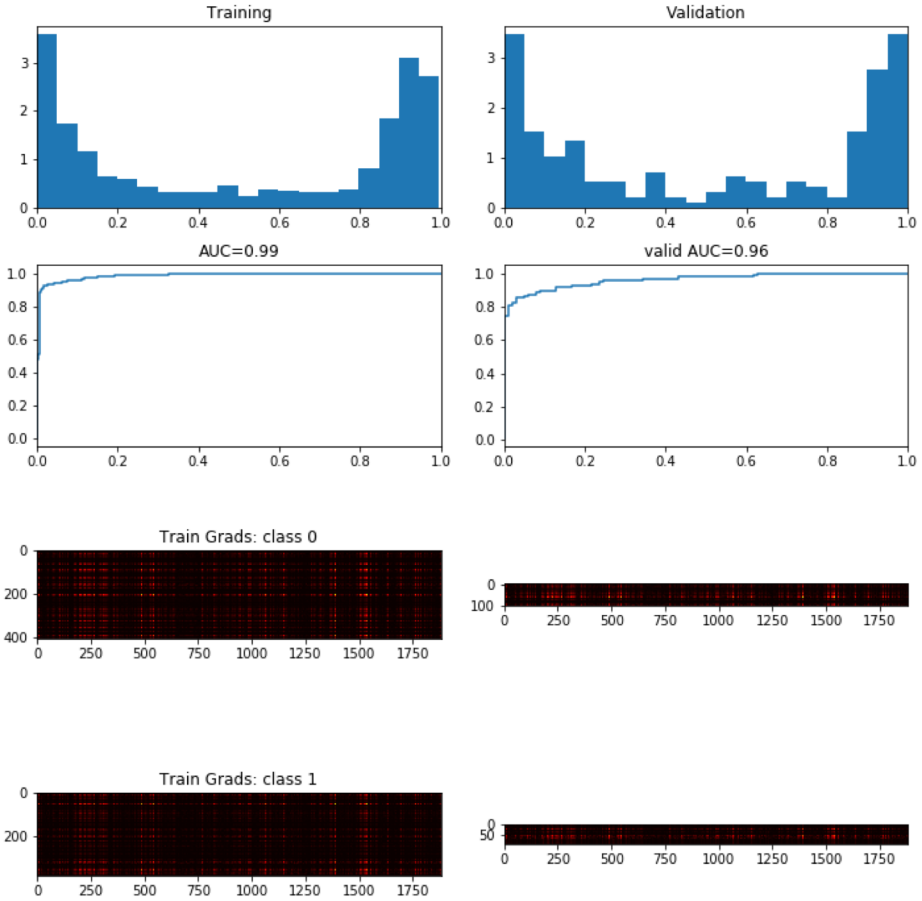


2. Binary Classification based on ~~multiple~~ two datasets







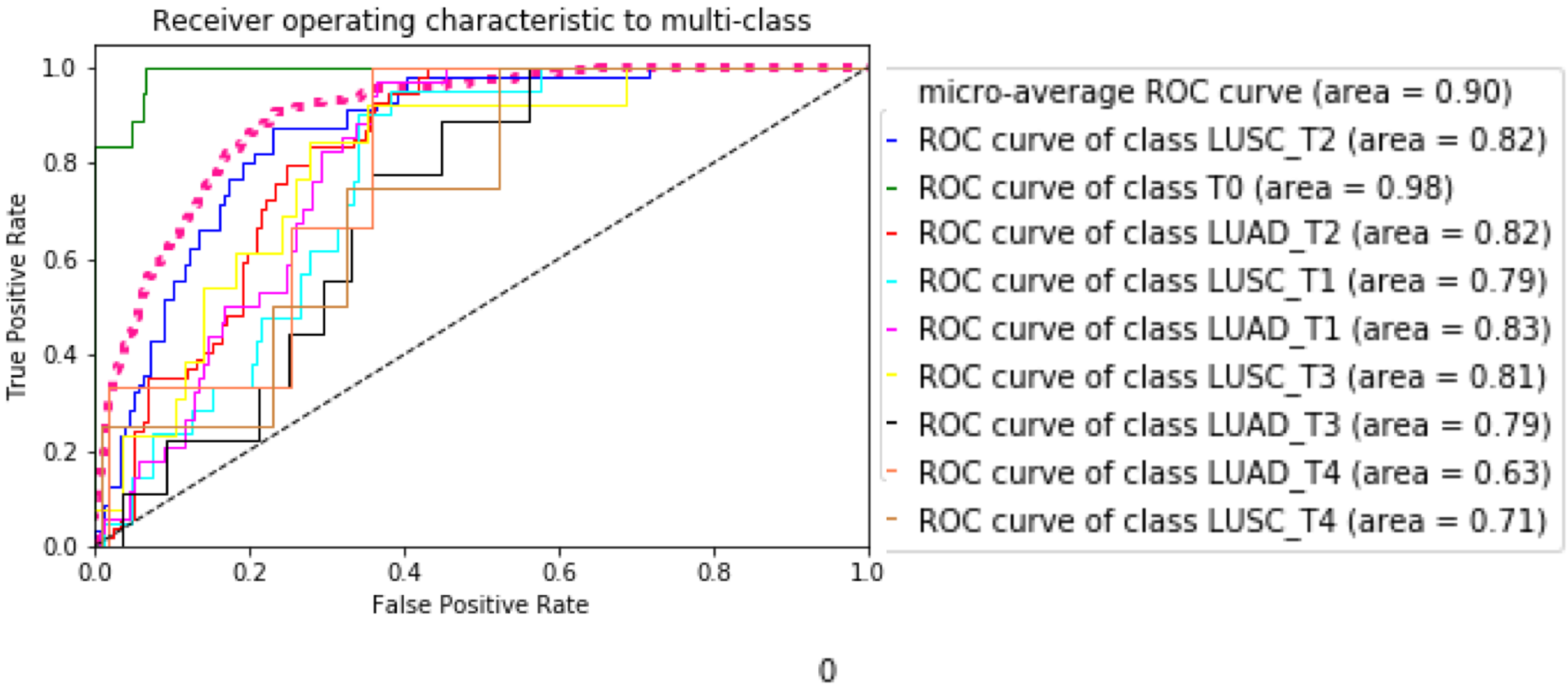


MLP with:

- 3 Dense layers
- 3 Dropout layers
- 2 Batch normalization

2. Multi Class based on two datasets

Again change of research question towards : Tumor stage classification with T stages



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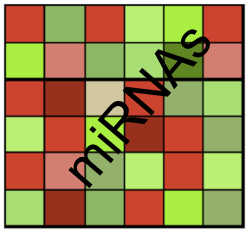
3. Clustering of patients based on molecular profile

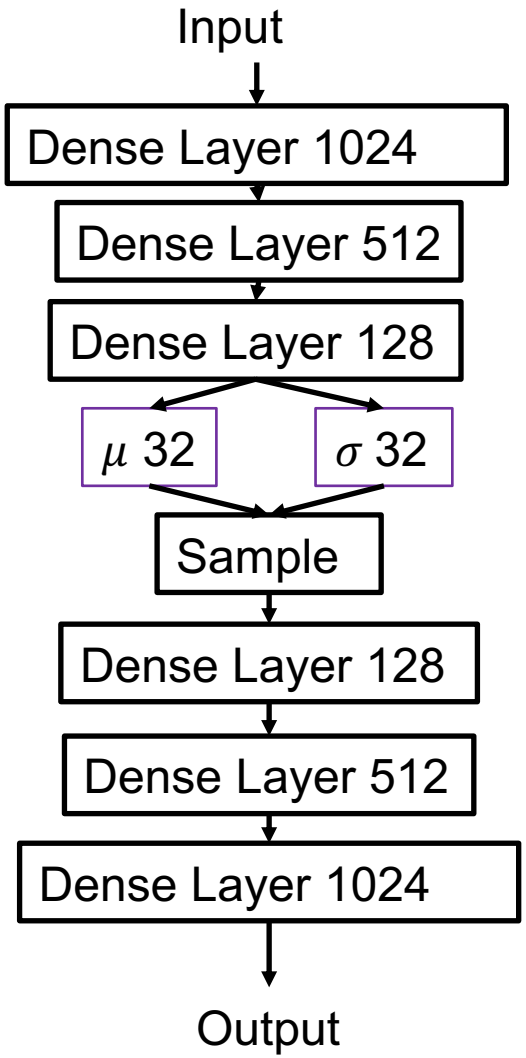
LUSC



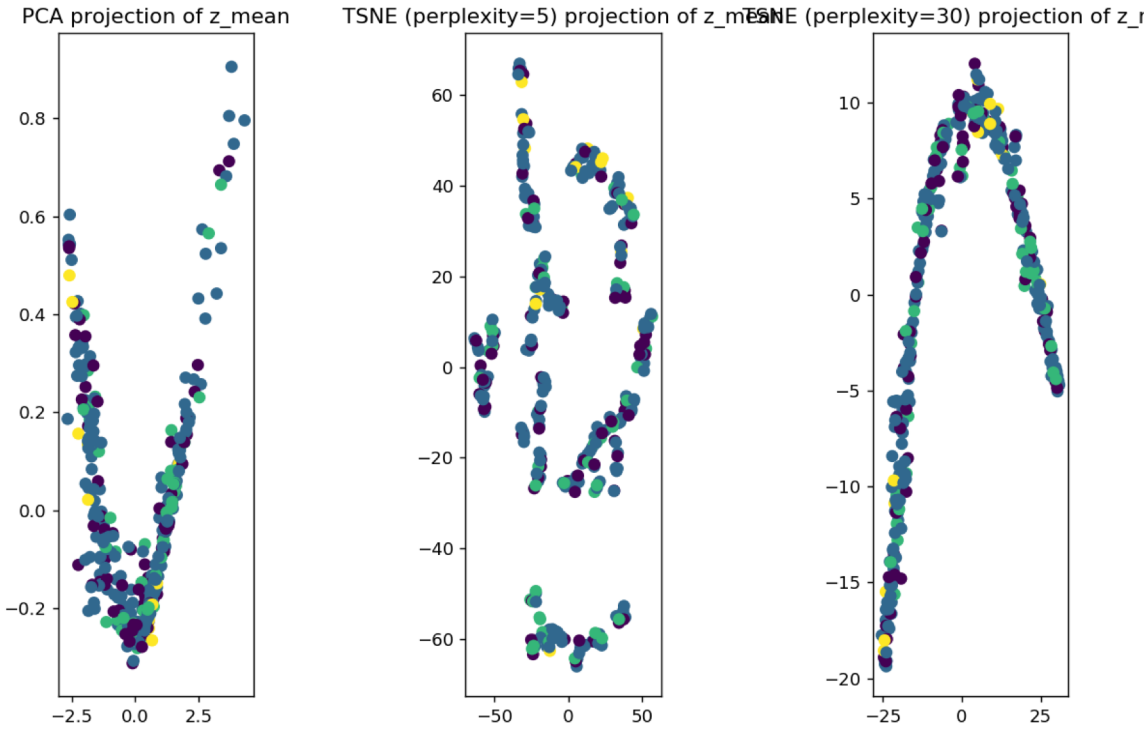
Variational Autoencoder

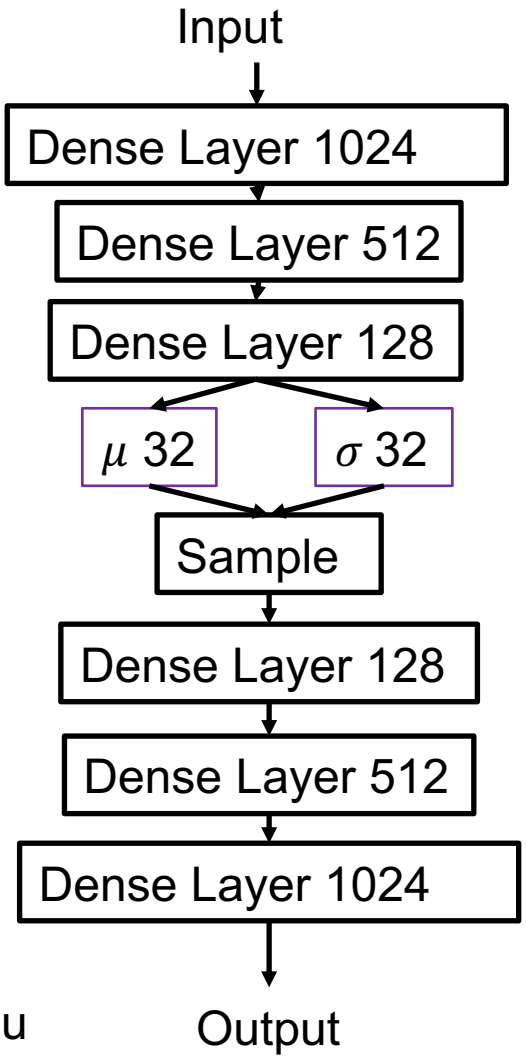
Desired clustering in 4 classes:
- T1
- T2
- T3
- T3

Activation function relu



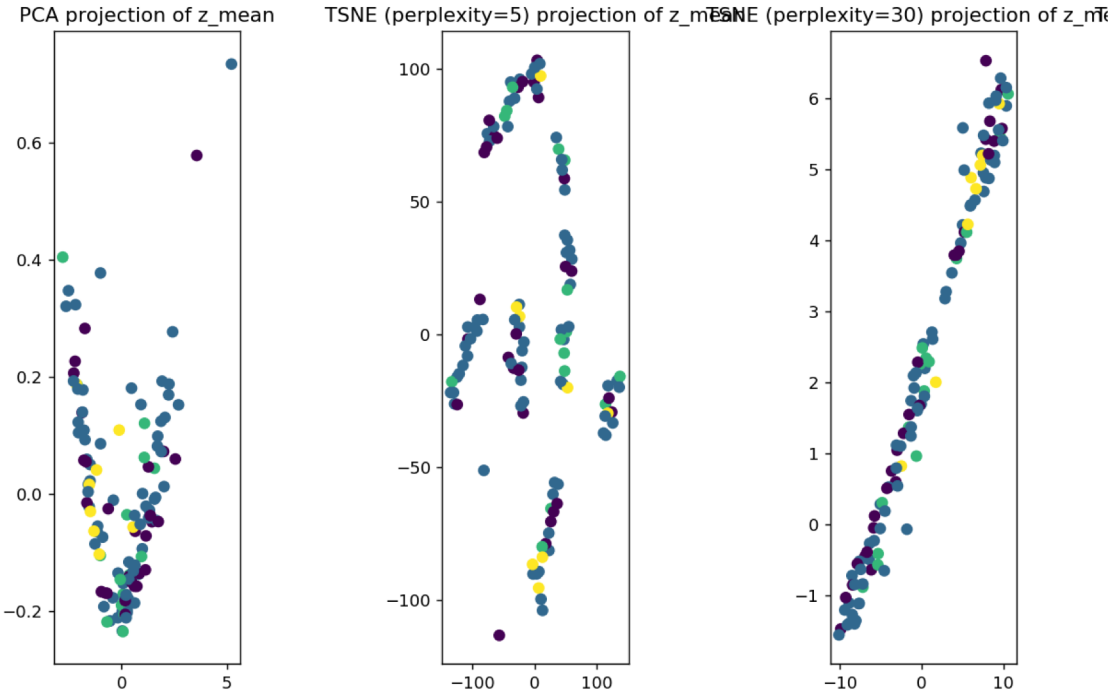
3. Training of variational Autoencoder

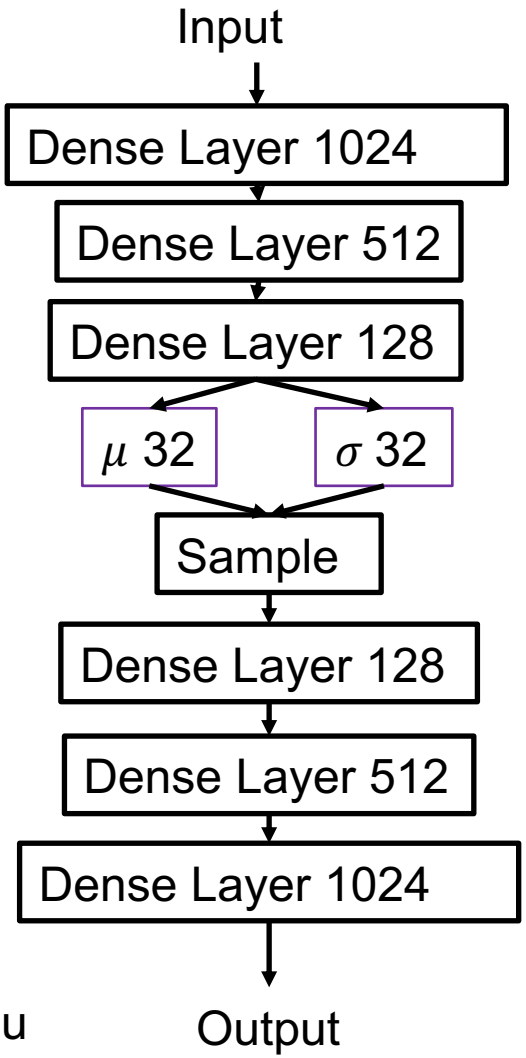




Activation function relu

3. Test of variational Autoencoder

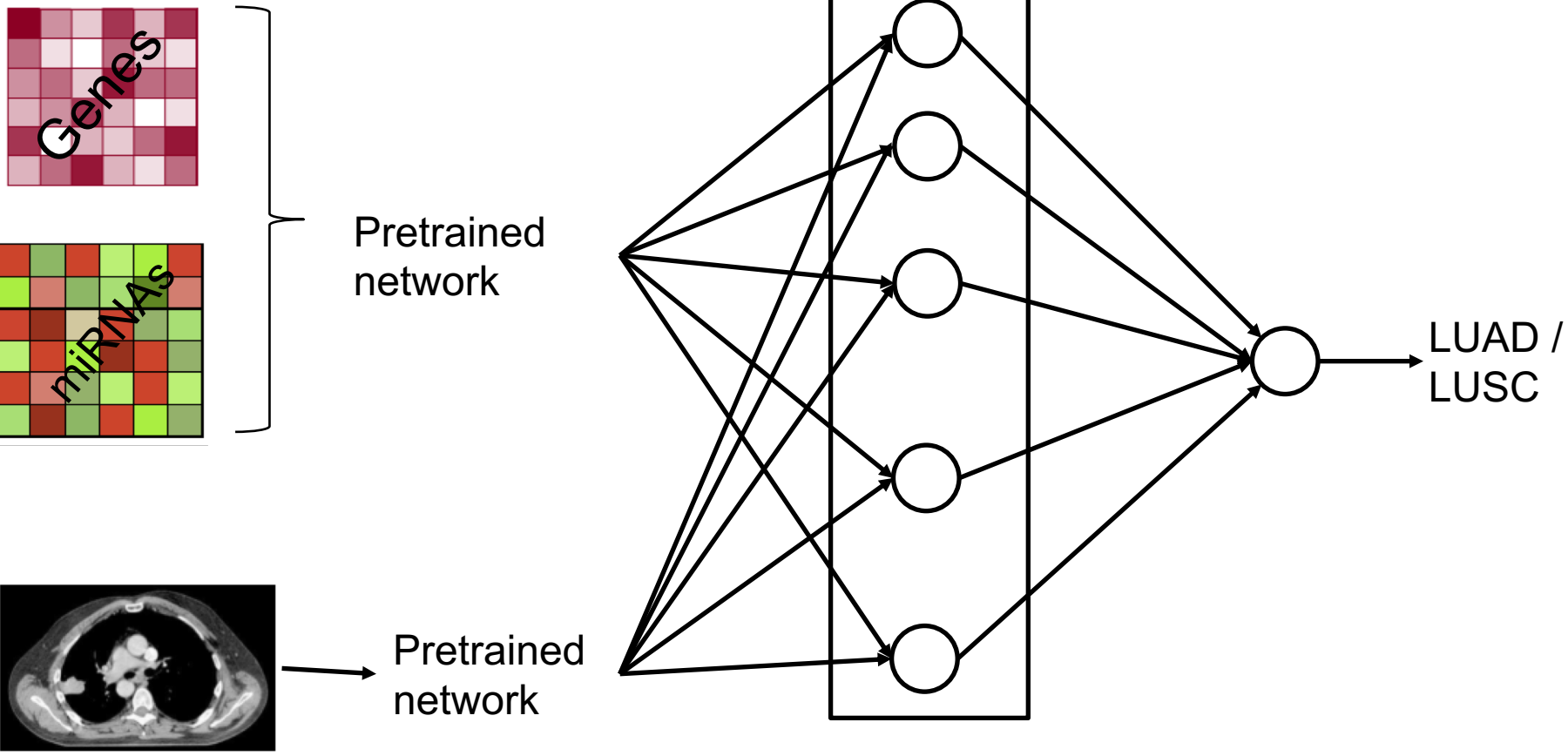




Activation function relu

Future of the project

Using transfer learning on our own build networks



One or multiple dense layers with dropout and batch normalization

LUNG-SQUAD Team

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