STAT 405 FINAL PROJECT

SKIN CANCER ANALYSIS: DNN

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Background

5.4 MM

Cases of skin cancer diagnosed per year

20%

Of Americans will develop skin cancer by 70

99%

survival rate with early detection

Lit Review

84%

sensitivity and specificity by dermatologists for BCC

15%

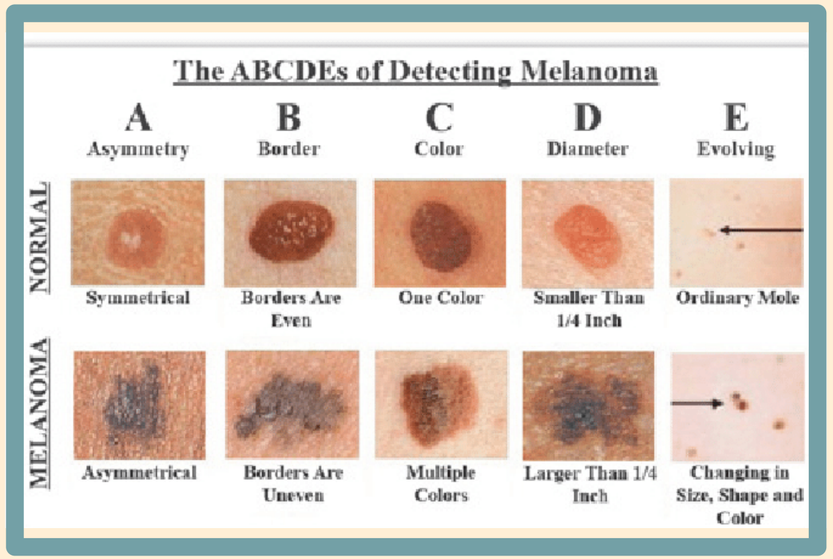
increase in accuracy when doctors use AI

10%

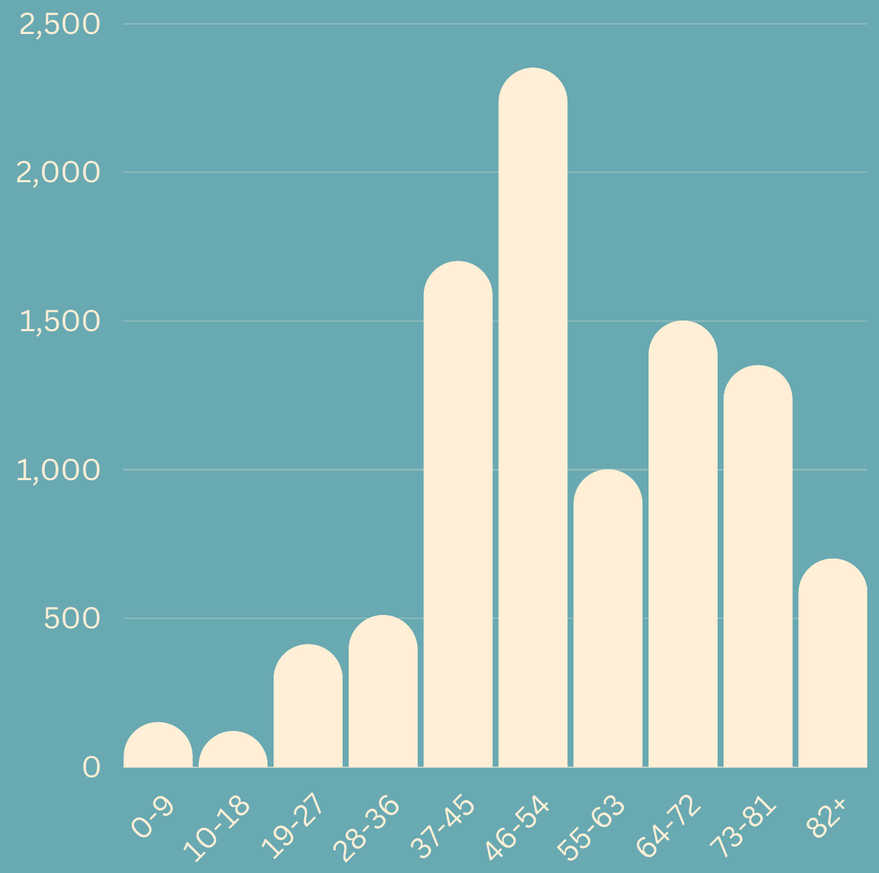
average image failure according to the 2018 classification study

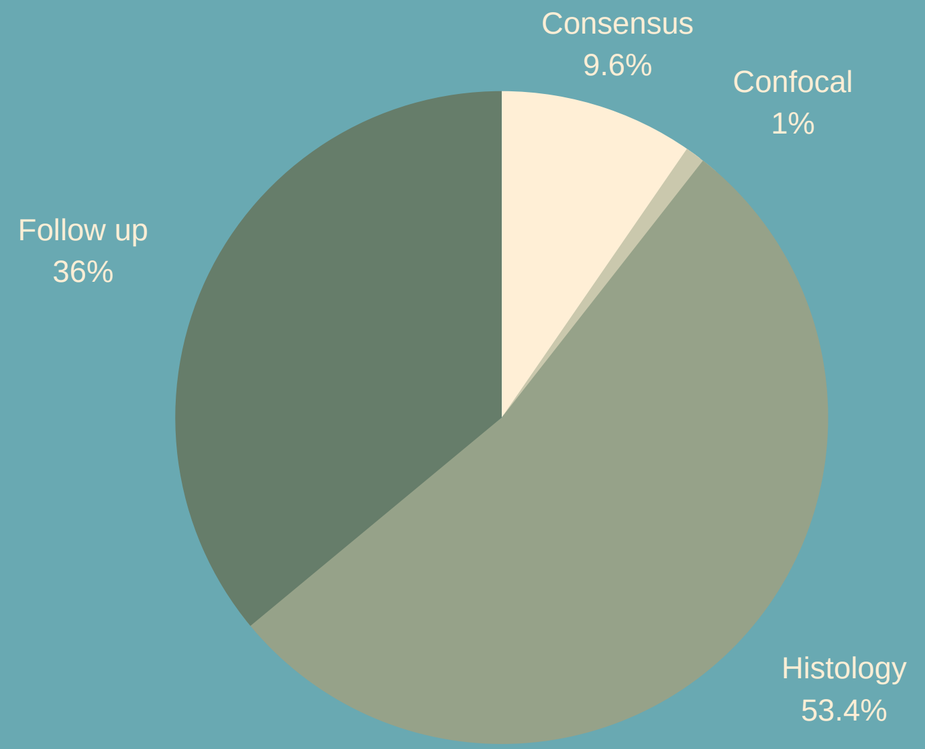
Description

- 10000 training Jpegs
  - 300kb each
- 1500 test
- Metadata: Age, Locus, Sex, Histology
- Competition - to compare our accuracies and efficacy



Distribution of Images by Age





Diagnosis Denotation

Packages

PyTorch with a conda environment

Preprocessing

Need to homogenize the location of the object in the center of frame.

Encoding

Used one hot encoding for metadata to be added to a later layer

Network

We used res net with some unfrozen layers, and later an ensemble

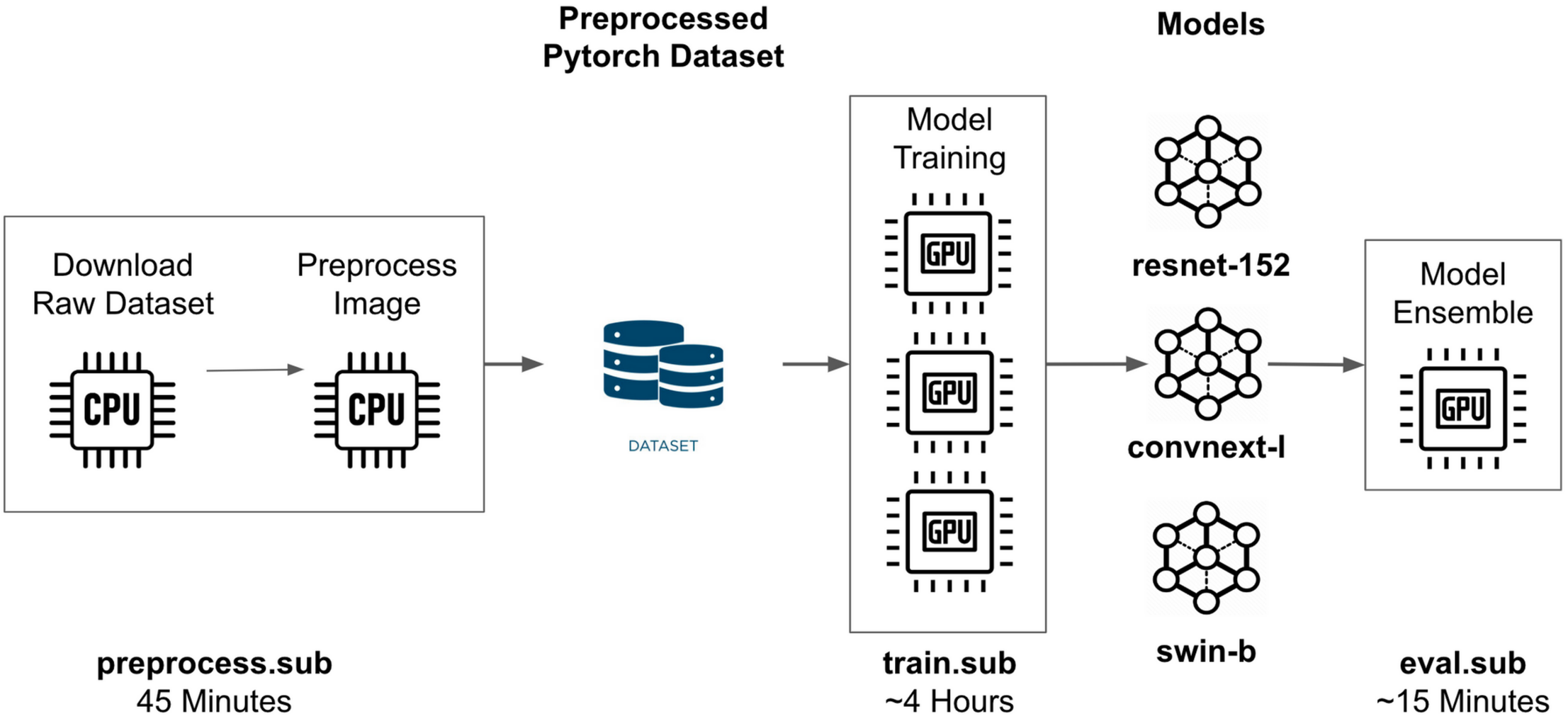
Metadata

Added this encoded data as a layer after running the images through the first few layers

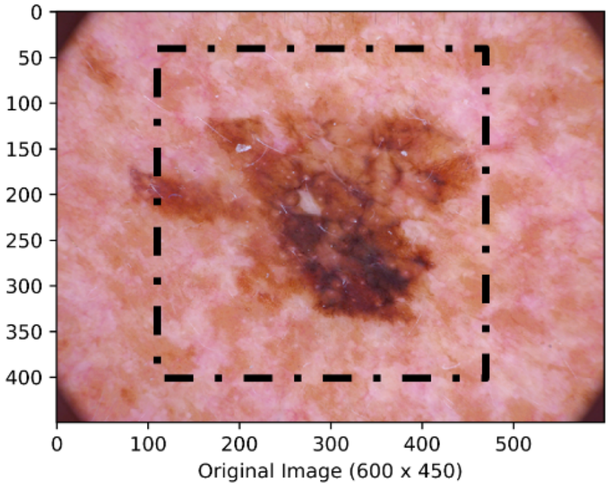
Results

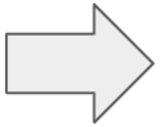
Differs from other methodologies. Parallel training for ensemble.

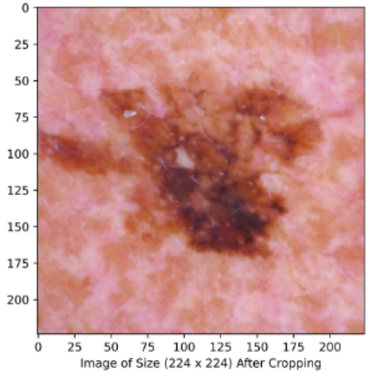
Computation Pipeline on CHTC

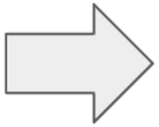


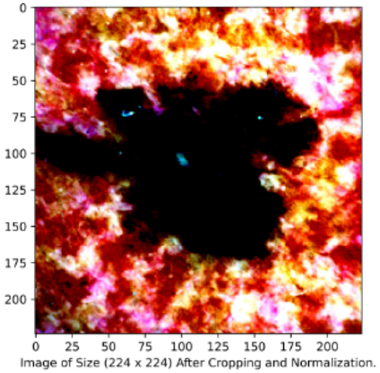
Preprocess









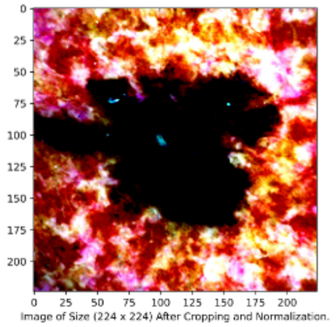


Original Image
(600 x 450)

Resized and Cropped Image
(224 x 224)

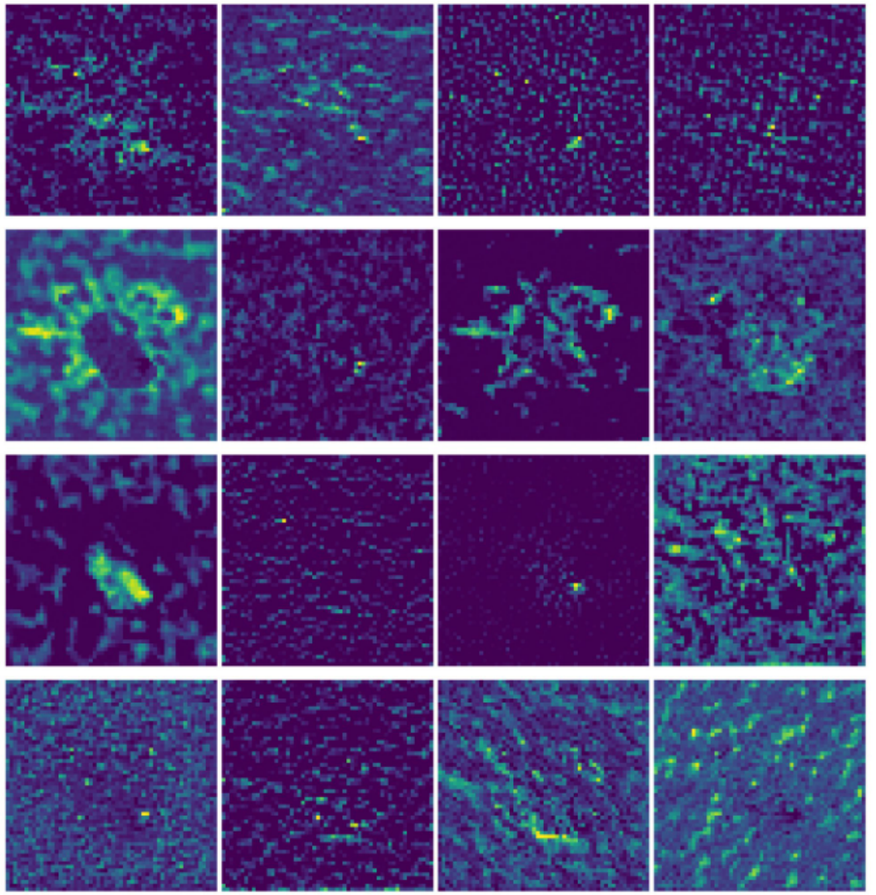
Normalized Image
(224 x 224)

Feature Extraction



Input Image
(224 x 224)

Deep
Neural
Network



Extracted Features
(28 x 28)

Deep
Neural
Network

[
0.14,
0.33,
0.12,
.
.
.
0.08,
0.19
]

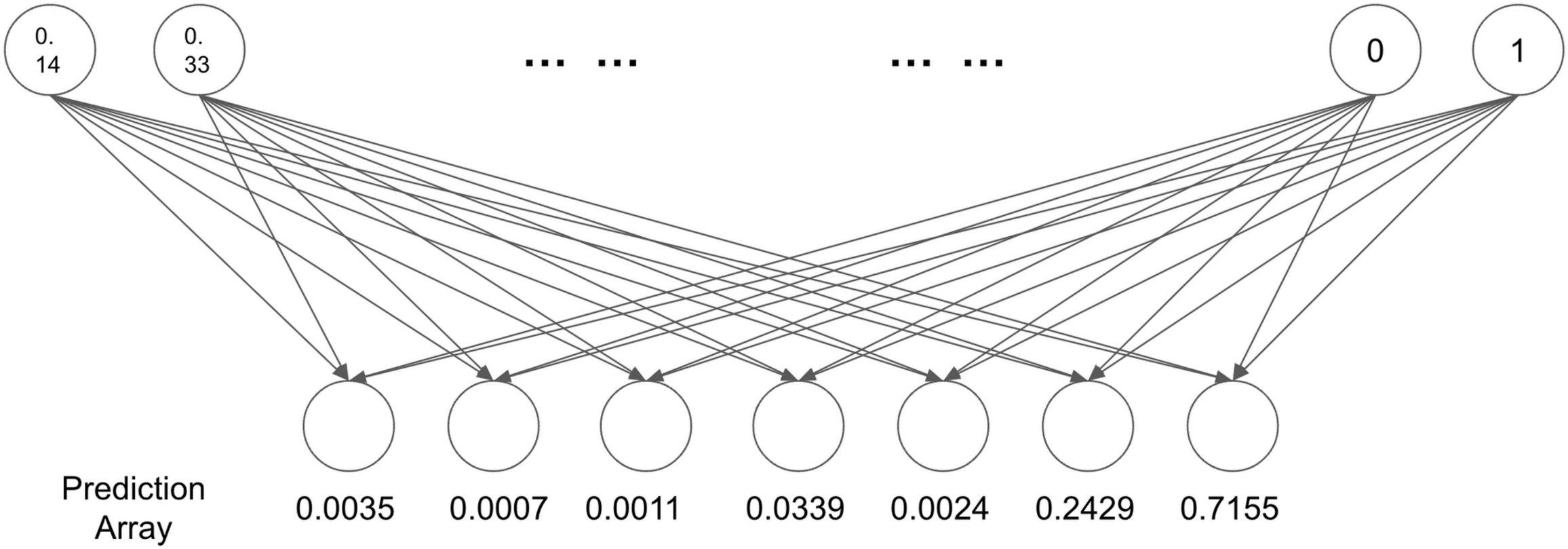
Features Vector
1 x 2048

Prediction

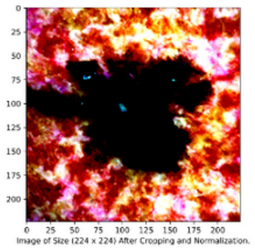
[0.14, 0.33, … , 0.08, 0.19] + **[0, 1, …, 0, 1]**

Feature Vector

Metadata Encoding



Ensemble Prediction



Input Image
(224 x 224)

Resnet-152

Swin-b

Convnext-l

Deep Neural Network

0.00, 0.00, 0.00, 0.04, 0.00, 0.24, 0.72

0.00, 0.00, 0.00, 0.03, 0.00, 0.24, 0.73

0.00, 0.00, 0.00, 0.06, 0.00, 0.14, 0.80

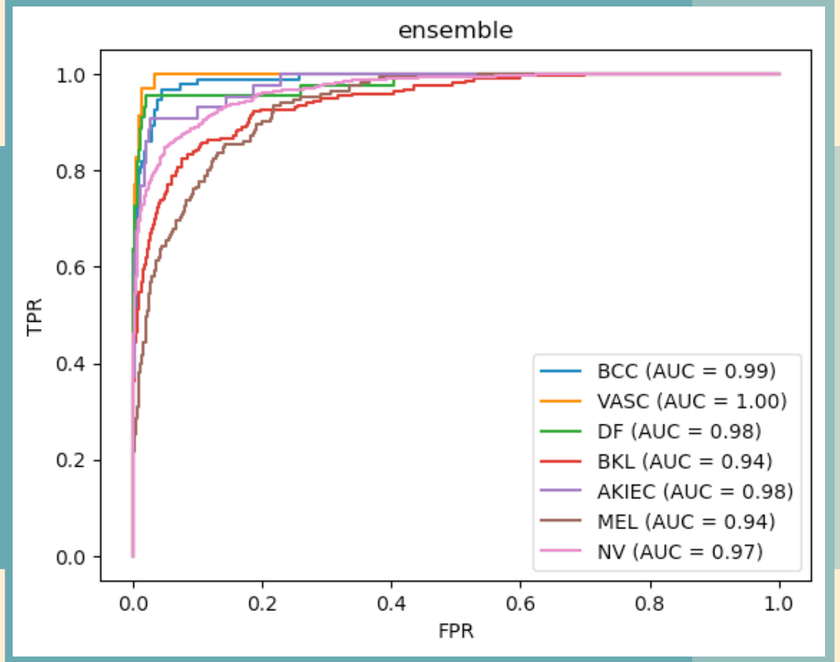
Prediction Array

Average

[
0.00,
0.00,
0.00,
.
.
.
0.16,
0.75
]

Ensembled Prediction Array

RESULTS



The resnet/swin/convnext ensemble

Overall accuracy of 79%

We ran two separate jobs, for preprocessing and one for the networks (gpu)

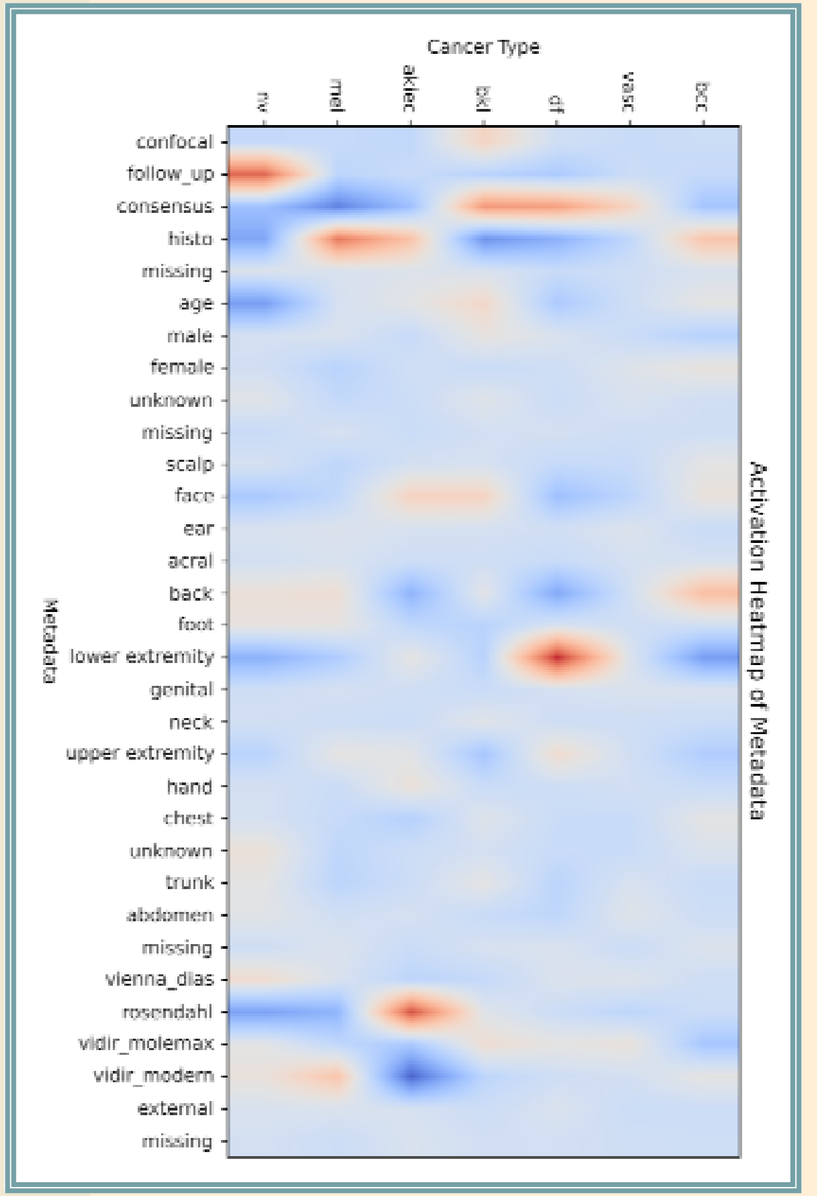
Memory utilized: 15GB
Disk space required: 40GB
NVIDIA A100-SXM4-80GB

	BCC	VASC	DF	BKL	AKIEC	MEL	NV
BCC	81	0	0	4	4	4	0
VASC	5	27	2	0	0	0	1
DF	2	0	36	2	1	1	2
BKL	10	2	1	165	13	20	6
AKIEC	2	0	0	2	35	4	0
MEL	5	2	0	10	5	139	10
NV	9	1	7	56	5	120	710

- Best = BCC @ 87.1
- Worst = BKL @ 76

	BCC	VASC	DF	BKL	AKIEC	MEL	NV	Mean Value
Accuracy	0.97	0.991	0.988	0.917	0.976	0.88	0.856	0.94
Specificity	0.977	0.997	0.993	0.943	0.981	0.889	0.968	0.964
Sensitivity	0.871	0.771	0.818	0.76	0.814	0.813	0.782	0.804
AUC	0.988	0.997	0.982	0.944	0.98	0.935	0.967	0.971

- Best AUC = .988
- Worst = .935



CONSIDERATIONS

- The most common physical indicator is a lump or localized swelling. Our data is trained on 2d images, which might limit efficacy.
- May have issues with lighting variability and lack of standardization
- Ways to improve:
  - Lighting
  - Dimensionality
  - More runs with different layers

SOURCES

https://pubmed.ncbi.nlm.nih.gov/9602875/

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1495212/

https://www.sciencedirect.com/science/article/pii/S0959804919303491

https://www.ncbi.nlm.nih.gov/books/NBK68729/

https://challenge.isic-archive.com/landing/2018/

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4513405/

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7519424/