

Exploring the power of transfer learning on Medical datasets



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Problem Statement

- Medical Image Classification
- Explore the power of **transfer learning** on medical images.
- Given images for different primary modalities (i.e. X-rays, CT scans, MRI, Ultrasounds), the aim is to **perform diverse classification tasks** (binary/multi-class, regression & multi-label) on the images using the power of Transfer Learning.

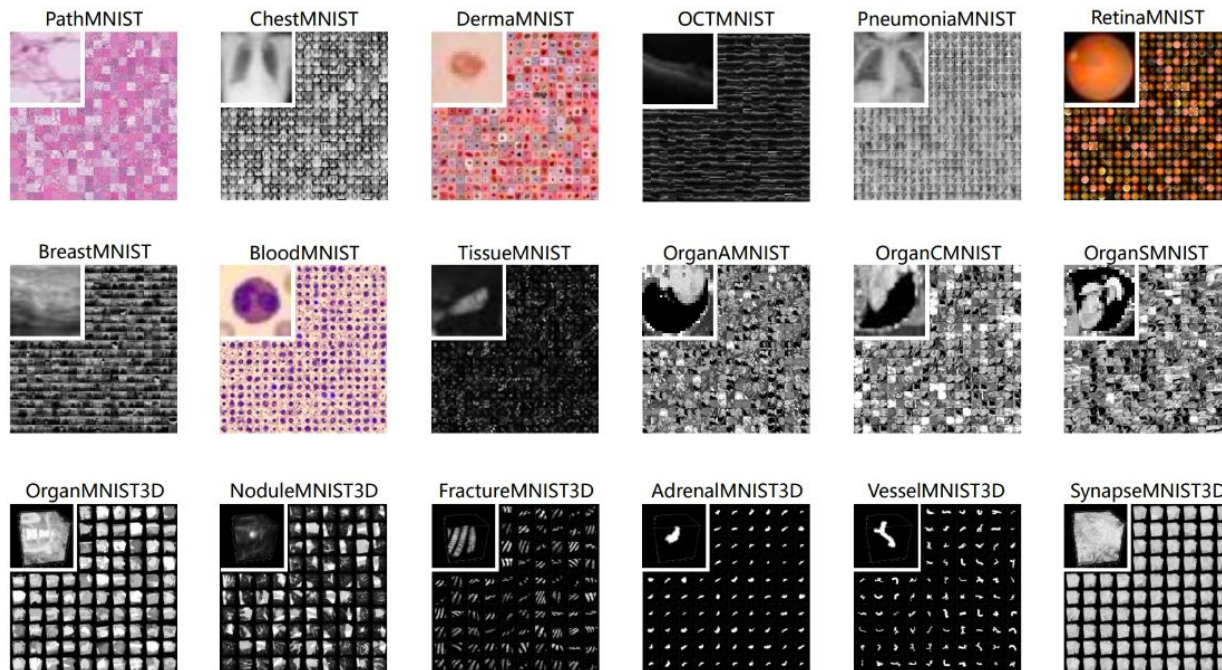
Motivation

- Has huge impact on **Computer-Aided Diagnosis (CAD)** systems.
- Can be used for creating **silver-standard labels** for **phenotyping** by pulling relevant images from EMRs.
- Image analysis can also help to identify the phenotypes, such as shape and texture of the cell of interest, that are **not otherwise easily measured**.
- Do not need to train the models from scratch and save training time and resources (P.S. and most importantly the Environment too!)

Source Dataset

- **MedMNIST** v2 dataset.
- Large scale collection of standardized biomedical images.
- Consists of both 2-D & 3-D images with **multiple modalities**

Jiancheng Yang, Rui Shi, Bingbing Ni. "MedMNIST Classification Decathlon: A Lightweight AutoML Benchmark for Medical Image Analysis". IEEE 18th International Symposium on Biomedical Imaging (ISBI), 2021.



Different Modalities

2-D Images

MedMNIST2D	Data Modality	Tasks (# Classes/Labels)
PathMNIST	Colon Pathology	Multi-Class (9)
ChestMNIST	Chest X-ray	Multi-Label (14) Binary-Class (2)
DermaMNIST	Dermatoscope	Multi-Class (7)
OCTMNIST	Retinal OCT	Multi-Class (4)
PneumoniaMNIST	Chest X-Ray	Binary-Class (2)
RetinaMNIST	Fundus Camera	Ordinal Regression (5)
BreastMNIST	Breast Ultrasound	Binary-Class (2)
BloodMNIST	Blood Cell Microscope	Multi-Class (8)
TissueMNIST	Kidney Cortex Microscope	Multi-Class (8)
OrganAMNIST	Abdominal CT	Multi-Class (11)
OrganCMNIST	Abdominal CT	Multi-Class (11)
OrganSMNIST	Abdominal CT	Multi-Class (11)

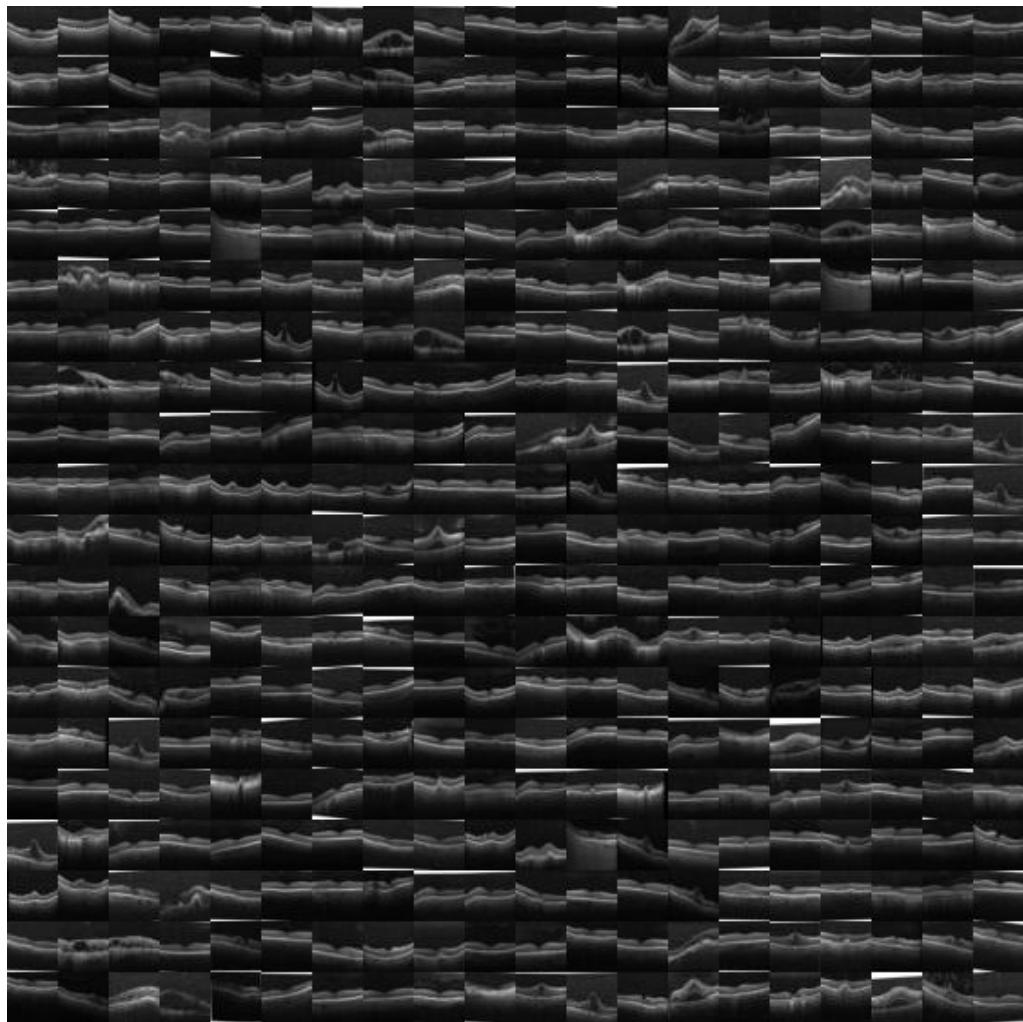
MedMNIST3D	Data Modality	Tasks (# Classes/Labels)
OrganMNIST3D	Abdominal CT	Multi-Class (11)
NoduleMNIST3D	Chest CT	Binary-Class (2)
AdrenalMNIST3D	Shape from Abdominal CT	Binary-Class (2)
FractureMNIST3D	Chest CT	Multi-Class (3)
VesselMNIST3D	Shape from Brain MRA	Binary-Class (2)
SynapseMNIST3D	Electron Microscope	Binary-Class (2)

3D Images

Datasets

OCTMNIST

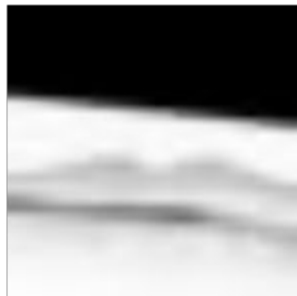
- **Modality:** Retinal OCT.
- **Number of Data samples:** 109,309
- **Number of Classes:** 4
- **Author:** Daniel S. Kermany, Michael Goldbaum, et al., "Identifying medical diagnoses and treatable diseases by image-based deep learning," Cell, vol. 172, no. 5, pp. 1122 – 1131.e9, 2018.



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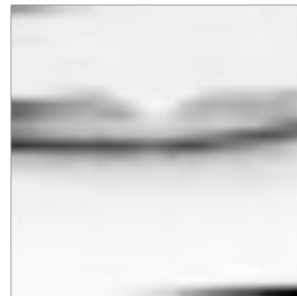
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3



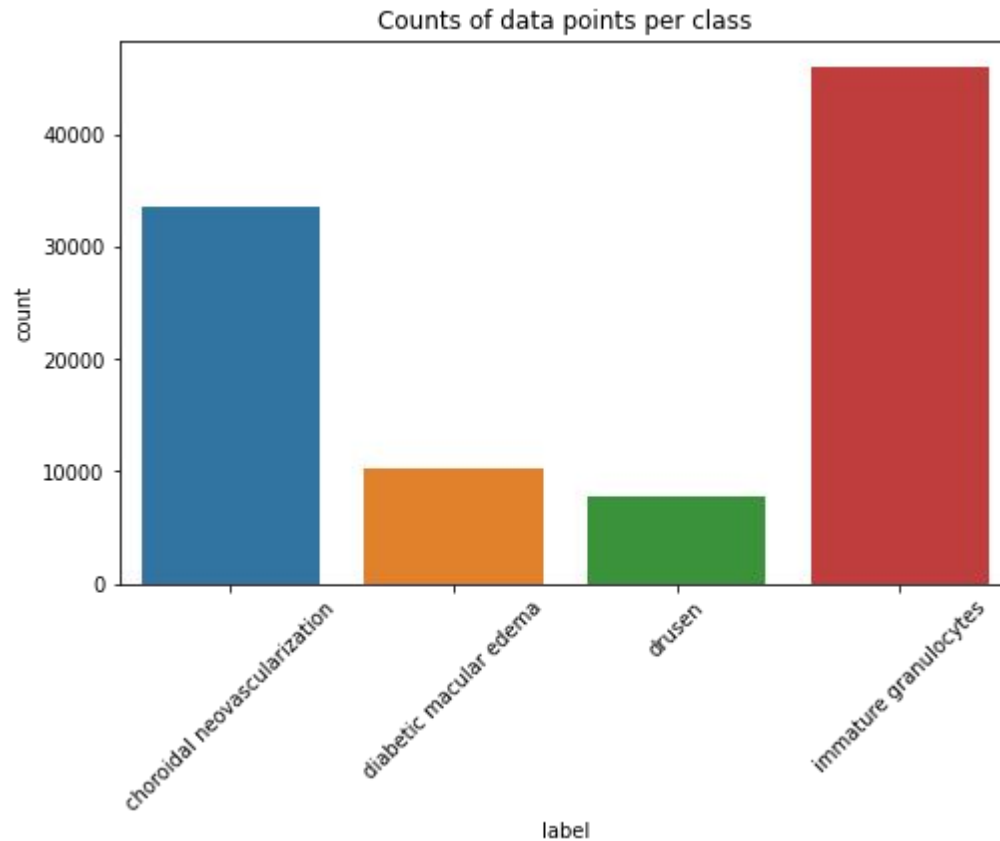
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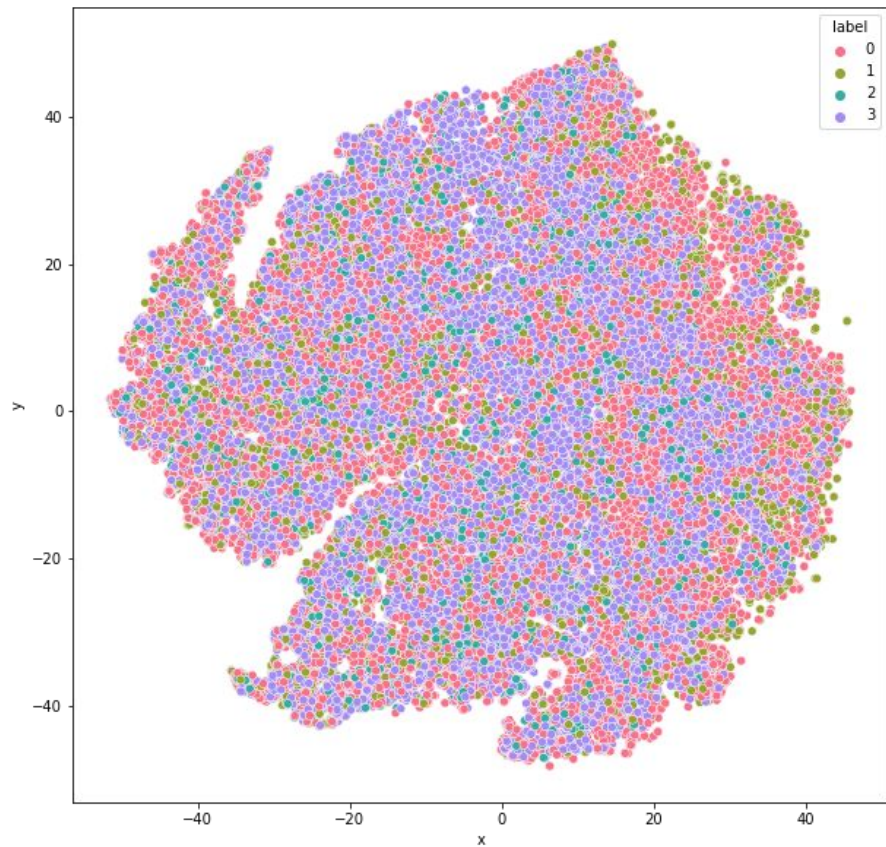
OctMNIST | Classes

Class Label	Label	Count
0	choroidal neovascularization	33484
1	diabetic macular edema	10213
2	drusen	7754
3	normal	46026

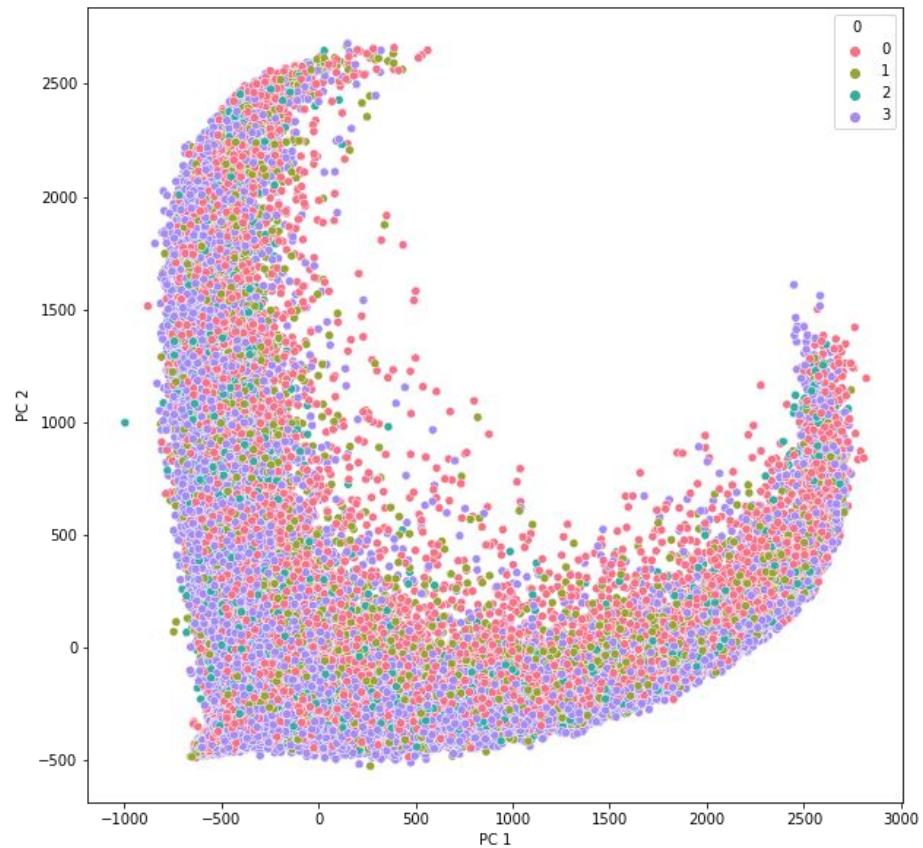
OctMNIST | Classes



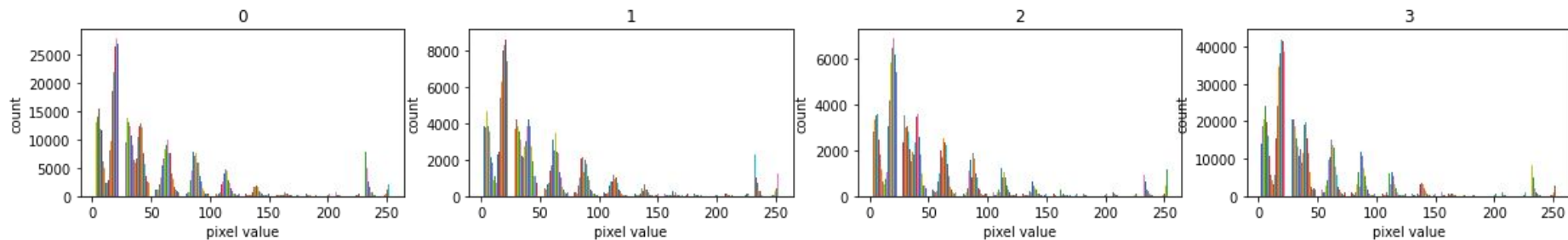
OctMNIST | TSNE



OctMNIST | PCA

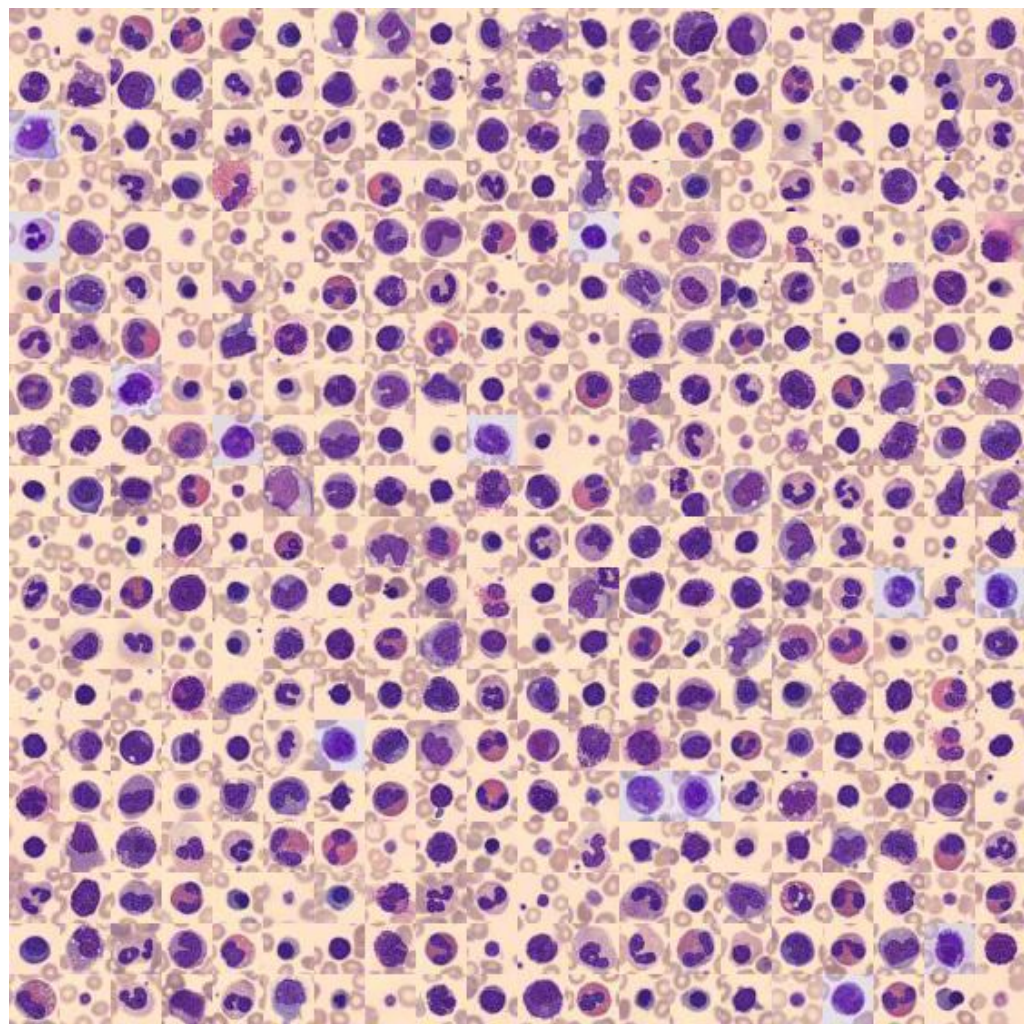


OctMNIST | Count vs Pixel Values for each Class



BloodMNIST

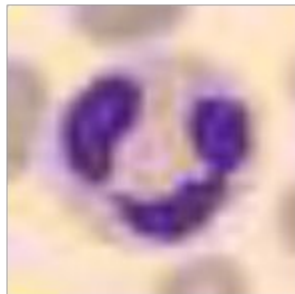
- **Modality:** Blood Cell Microscope
- **Number of Data samples:** 17,092
- **Number of Classes:** 8
- **Author:** Andrea Acevedo, Anna Merino, et al., "A dataset of microscopic peripheral blood cell images for development of automatic recognition systems," Data in Brief, vol. 30, pp. 105474, 2020



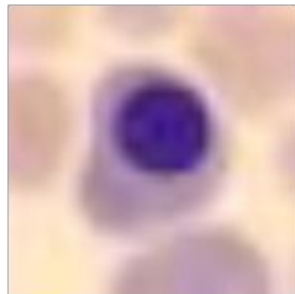
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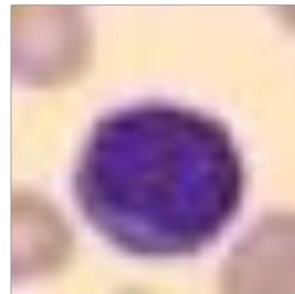
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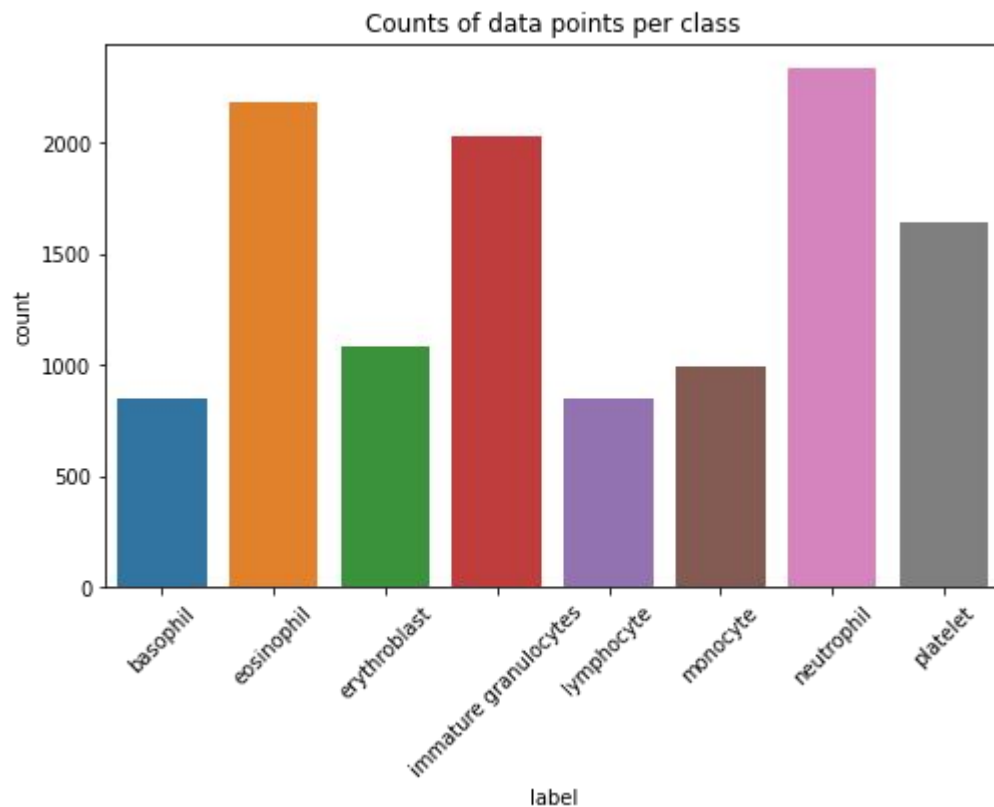
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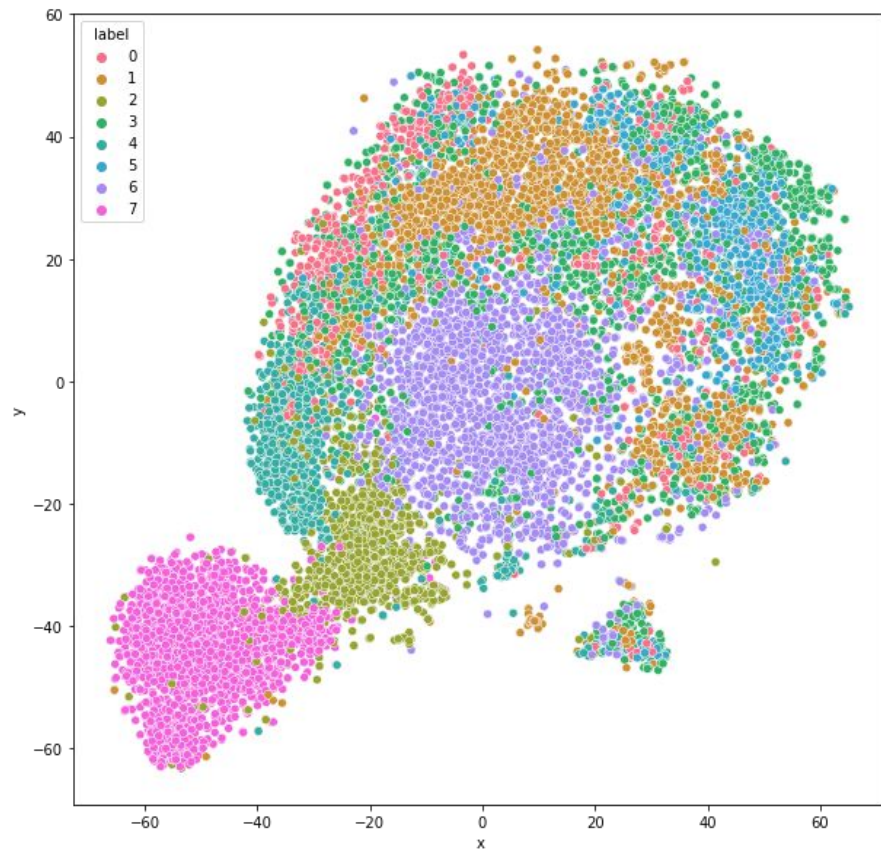
BloodMNIST | Classes

Class Label	Label	Count
0	basophil	852
1	eosinophil	2181
2	erythroblast	1085
3	immature granulocytes	2026
4	lymphocyte	849
5	monocyte	993
6	neutrophil	2330
7	platelet	1643

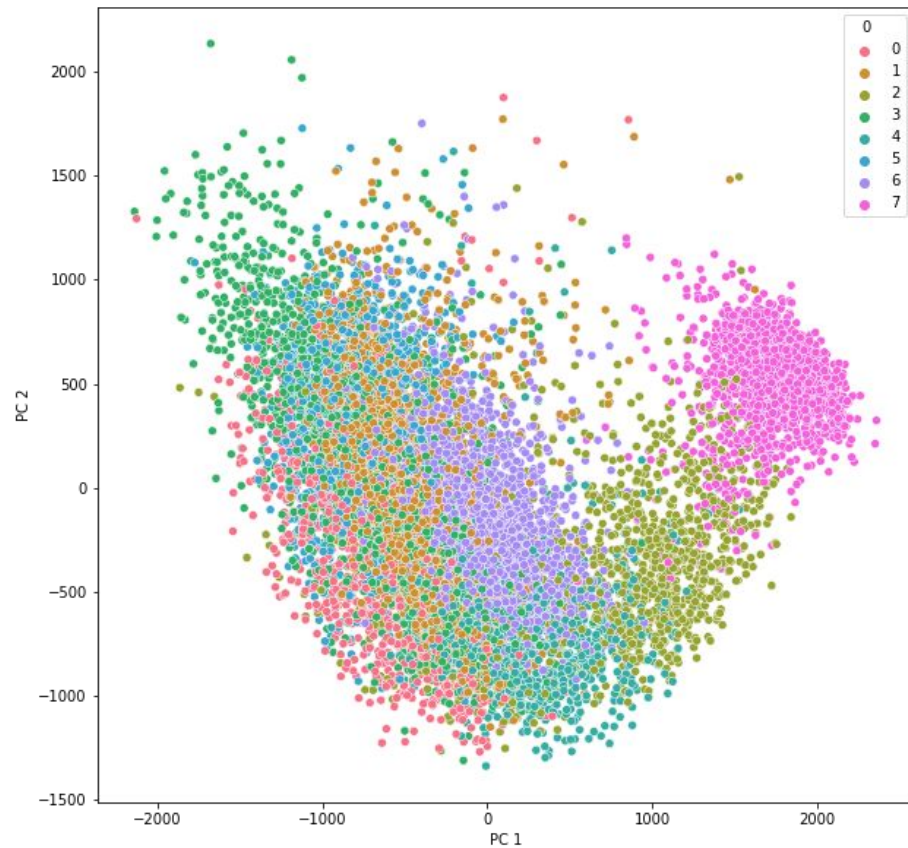
BloodMNIST | Classes



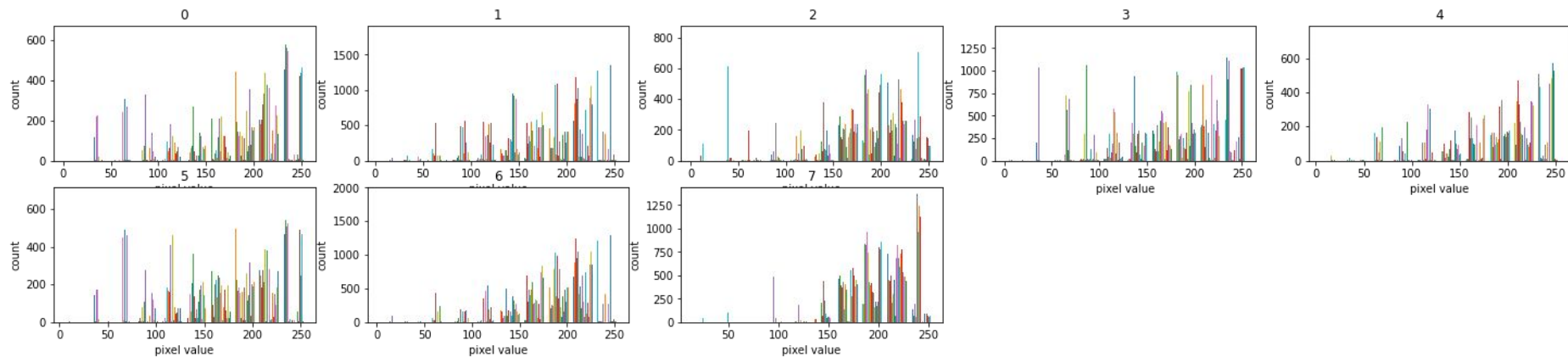
BloodMNIST | TSNE



BloodMNIST | PCA

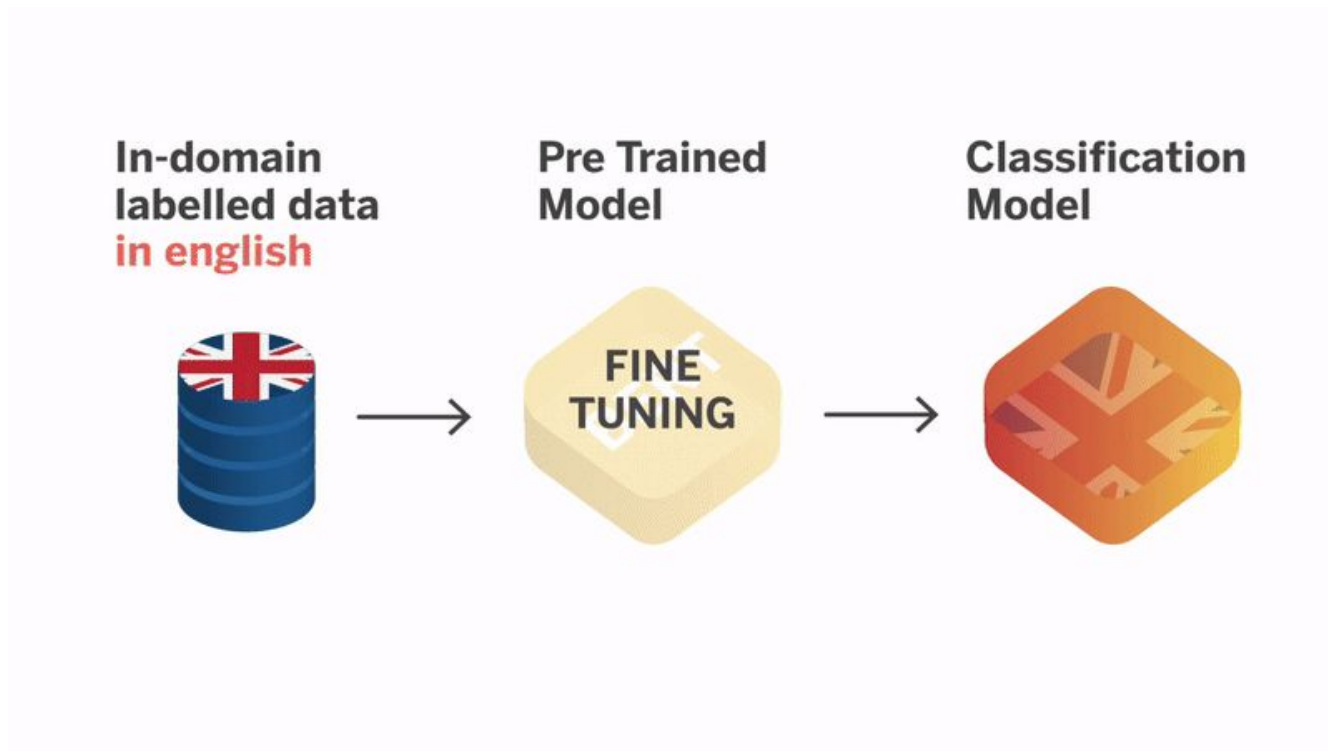


BloodMNIST | Count vs Pixel Values for each Class

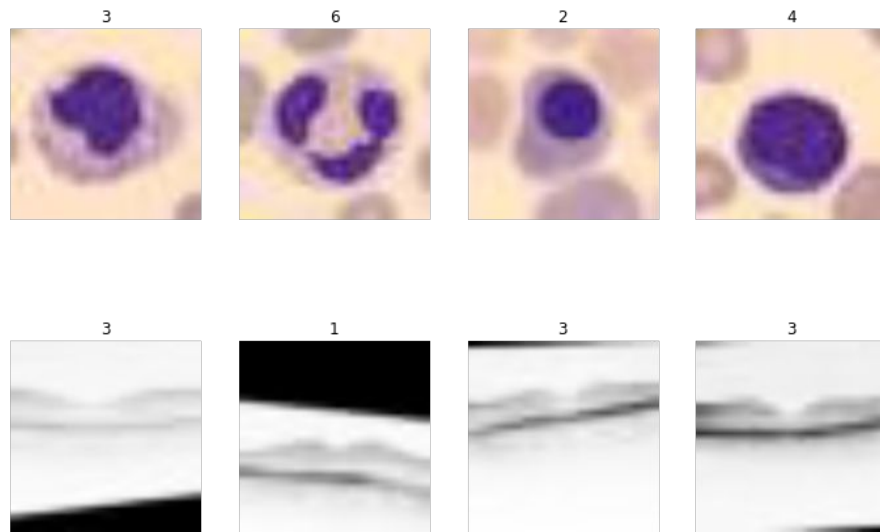
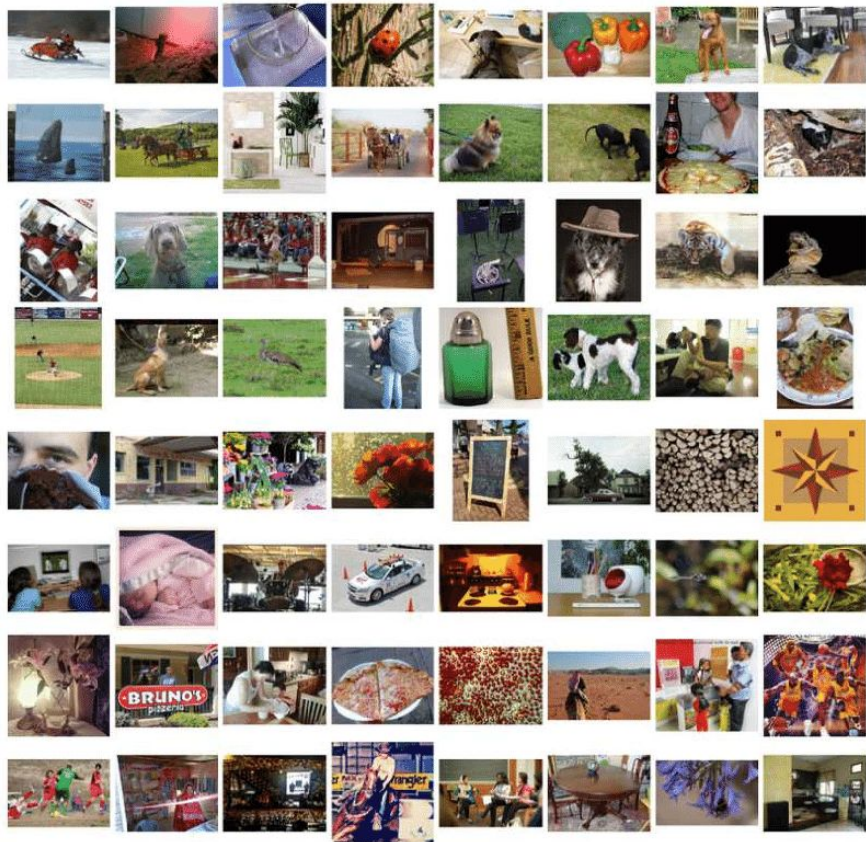


Methodology

Transfer learning



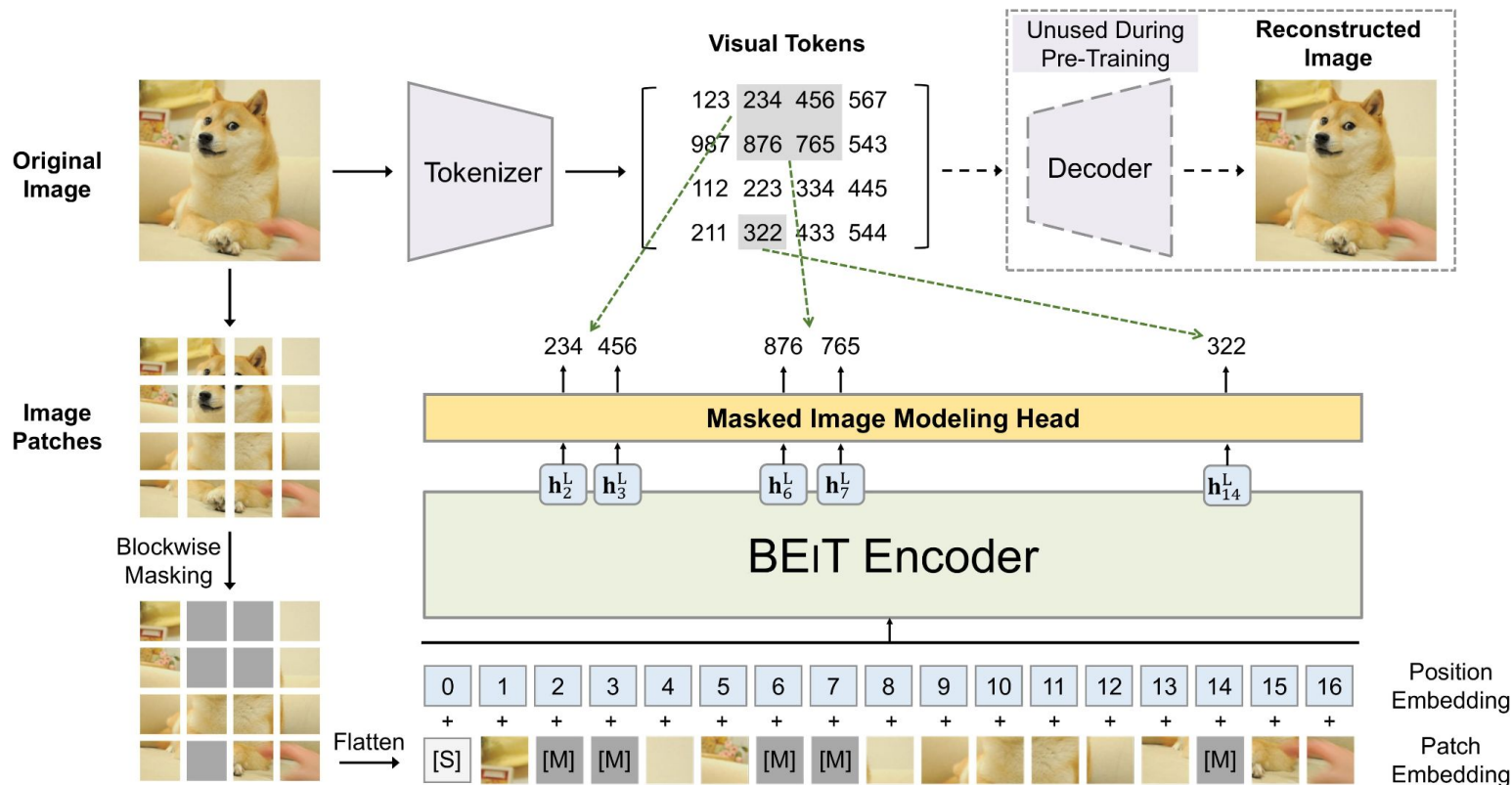
Transfer Learning



Vision Transformers



Architecture of BEiT (Pre-training methodology)



Baselines (Accuracy Scores)

Model Name	BloodMNIST	OctMNIST
Resnet-18	0.958	0.743
Resnet-50	0.956	0.762
auto-sklearn	0.878	0.601
AutoKeras	0.961	0.763
Google AutoML Vision	0.966	0.771

Models Used and Results Obtained (Accuracy Scores)

Model	Specification	Blood MNIST	OCT MNIST
AlexNet		0.90	0.72
BEiT		0.9664	0.818
Inception		0.95	0.73
VGG	VGG-16	0.73	0.67
	VGG-19	0.87	0.72
ResNet	Resnet-18	0.80	0.69
	Resnet-34	0.92	0.72
	Resnet-50	0.92	0.64
	Resnet-101	0.93	0.64
	Resnet-152	0.82	0.68
SqueezeNet		0.73	0.58

Learnings applied from the Course

- Applications of Machine Learning
- Predictive Modelling
- BERT Models
- Transformer Models
- Transfer Learning

Individual Contributions

Member Name & Roll Number		Contribution
Ananya Jain	2019408	EDA, VGG, Report, Presentation
Kirthana Natarajan	2019053	EDA, Resnet, Report, Presentation
Prashasti Agarwal	2019075	Resnet, Report, Presentation
Prithish Wadhwa	2019440	Squeezenet, Alexnet, Resnet, Report, Presentation
Raghav Nakra	2019083	VGG, Presentation
Shashank Dargar	2019107	BEiT, Inception
Shounak Ghatak	2019109	BEiT, Inception

Thank You

