Aleatoric Uncertanity Estimation using Bayesian Deep Learning on Magnetic Resonance Imaging(MRI)

Synthetic Health Data Hackathon 2020

REGION H Rigshospitalet

Digital Hub Denmark

Erhvervsministeriet

biolib

Our Amazing Team

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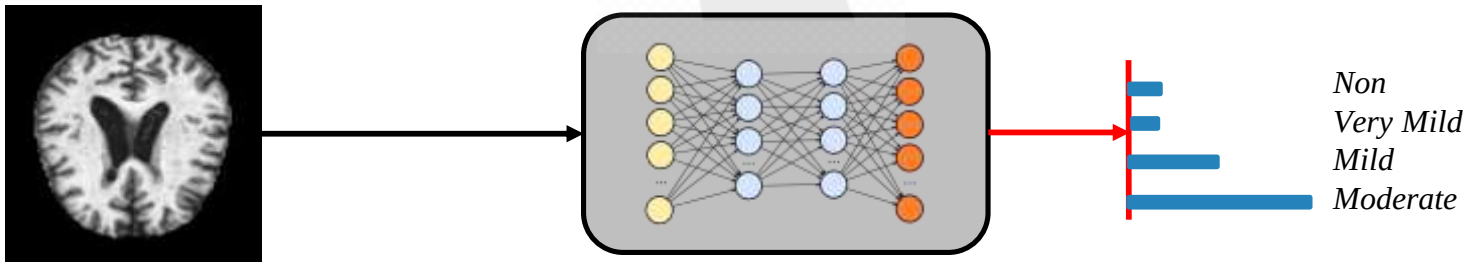
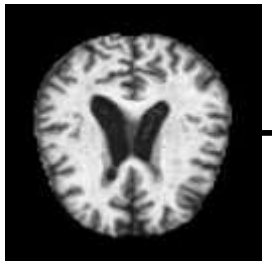
UNIVERSITY OF EASTERN FINLAND

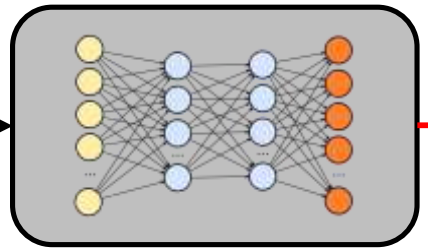
Can we TRUST AI models?



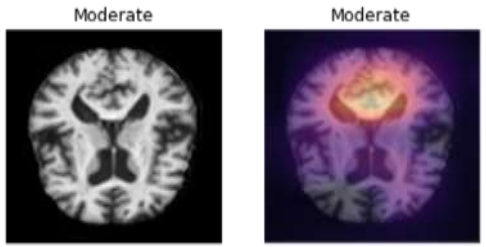
Can we TRUST AI models?

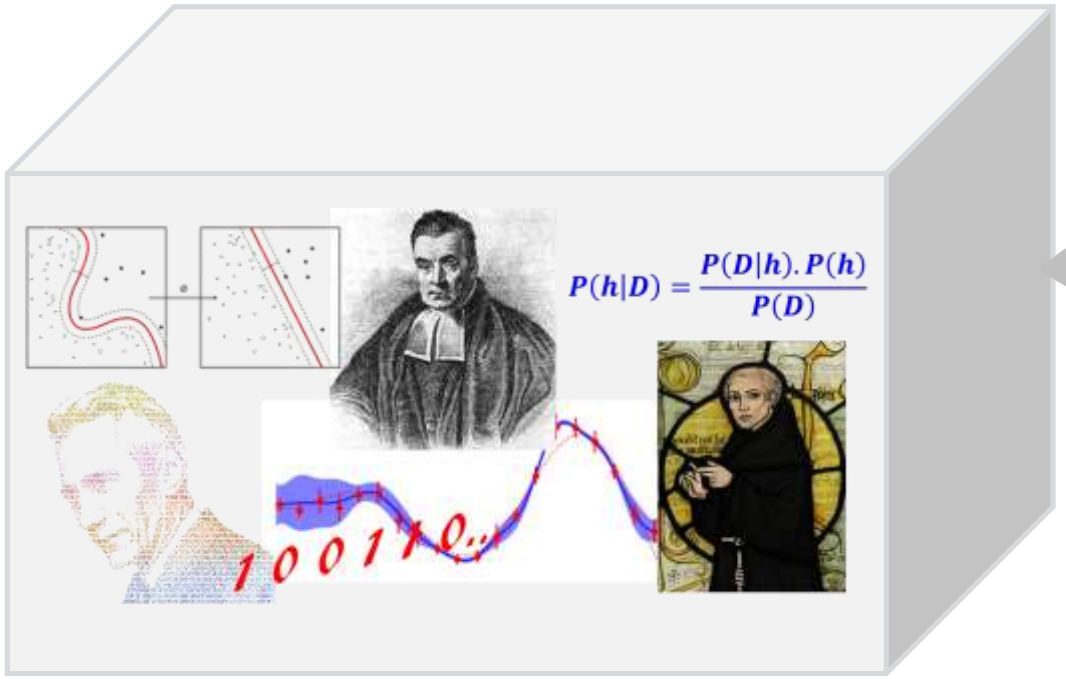


Input Image



Black box AI model

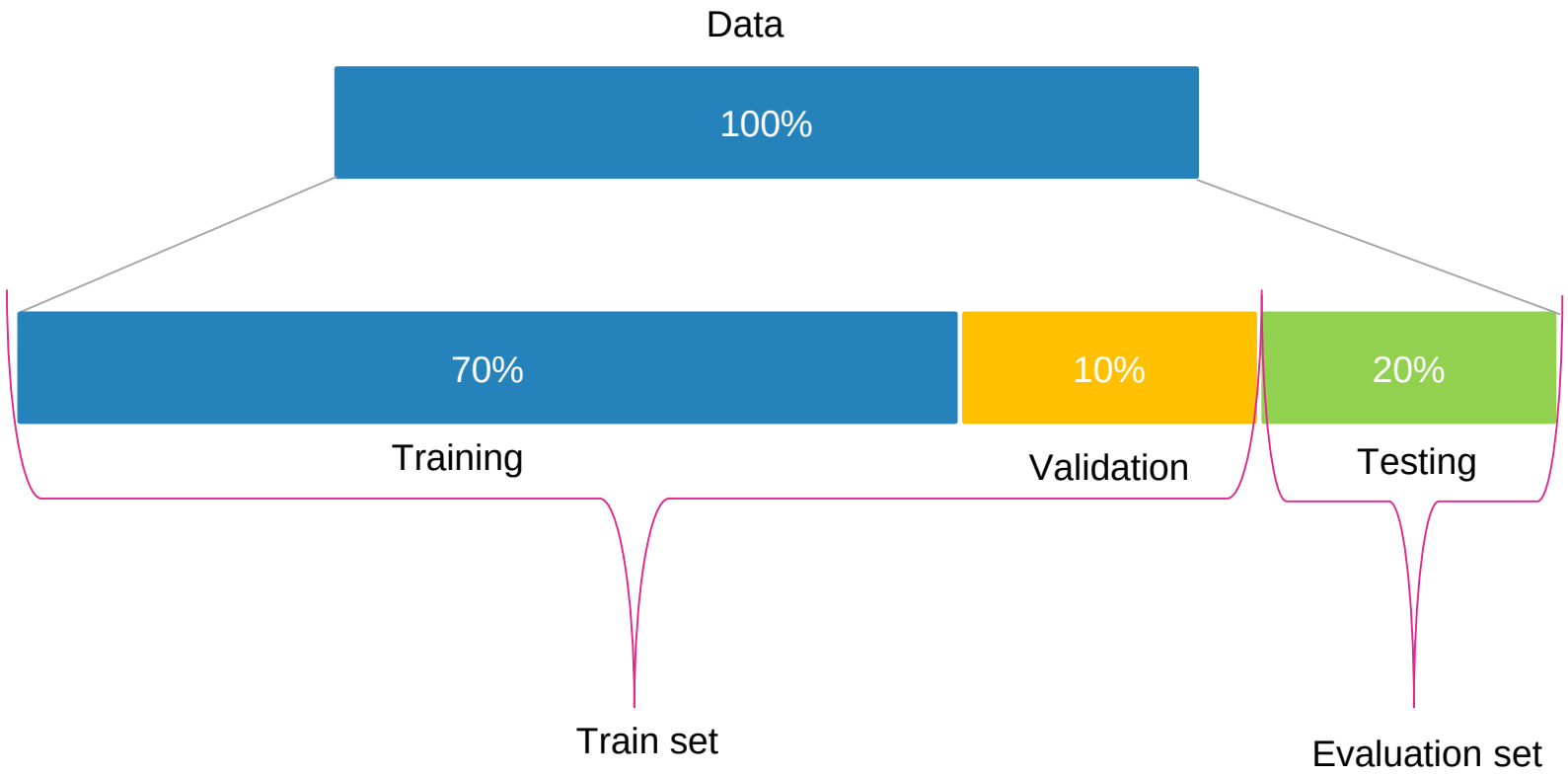




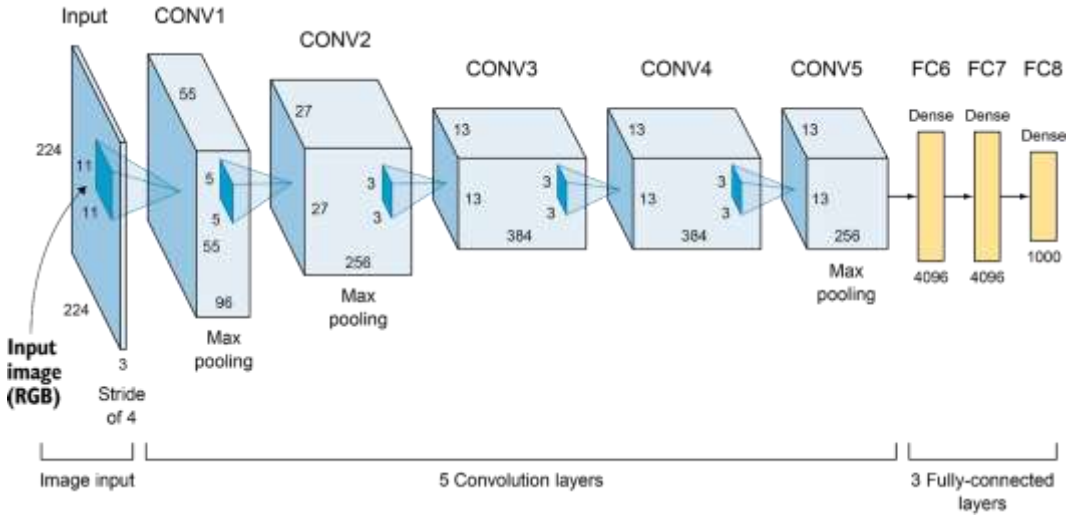
Explainable AI model

Image credits: https://towardsdatascience.com/when-bayes-ockham-and-shannon-come-together-to-define-machine-learning-96422729a1ad

Dataset split protocal



AlexNet



Trained on synthetic dataset and performance evaluated on real dataset

Accuracy of the network on the real images: 41 %

Accuracy of Mild : 6 % 717
Accuracy of Moderate : 53 % 52
Accuracy of Non : 65 % 2560
Accuracy of VeryMild : 18 % 1792

Trained on synthetic train dataset and performance evaluated on synthetic test dataset

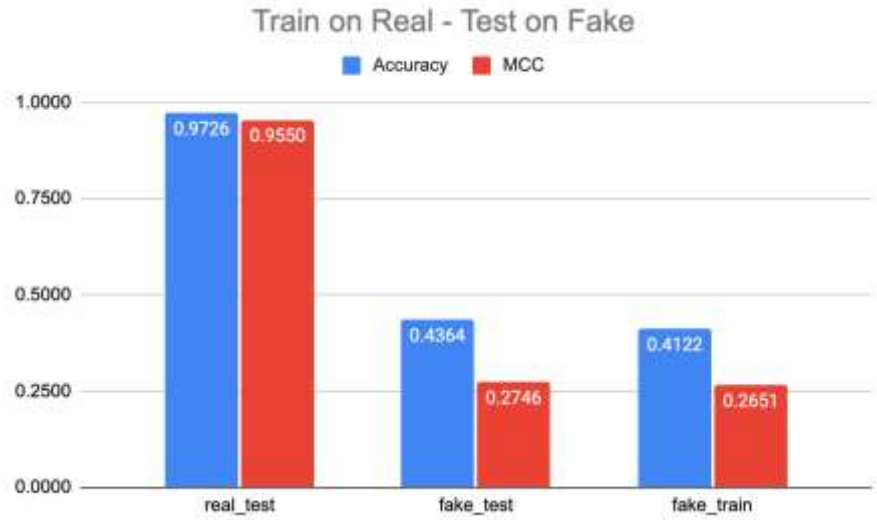
Accuracy of the network on the test images: 100 %

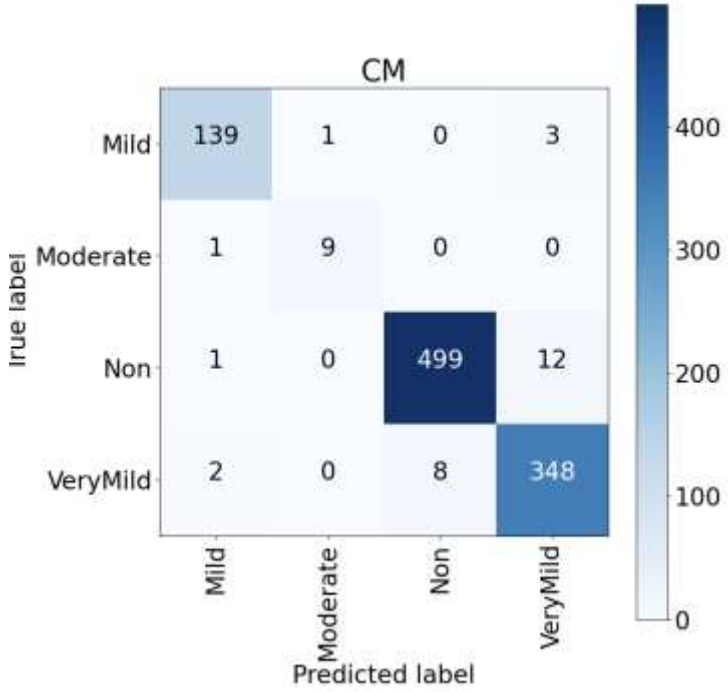
Accuracy of Mild : 100 % 609
Accuracy of Moderate : 100 % 607
Accuracy of Non : 100 % 586
Accuracy of VeryMild : 100 % 598

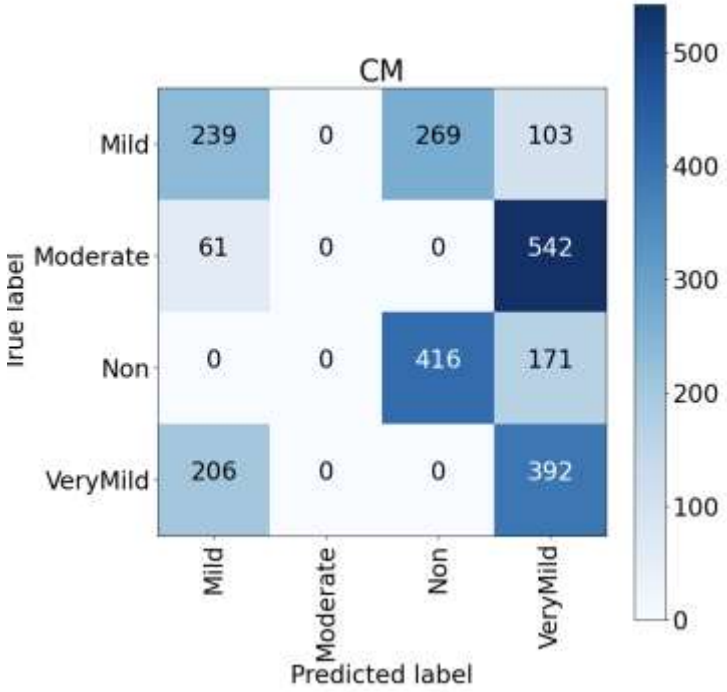
Image credits: https://www.kaggle.com/l0new0lf/alexnet

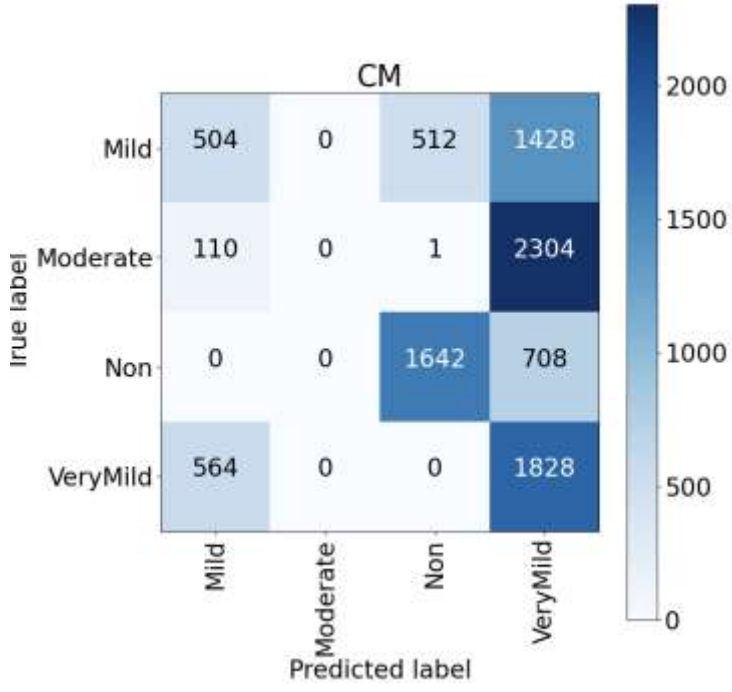
AlexNet with dropout

Trained on real datset and performance evaluated on synthetic (fake) dataset

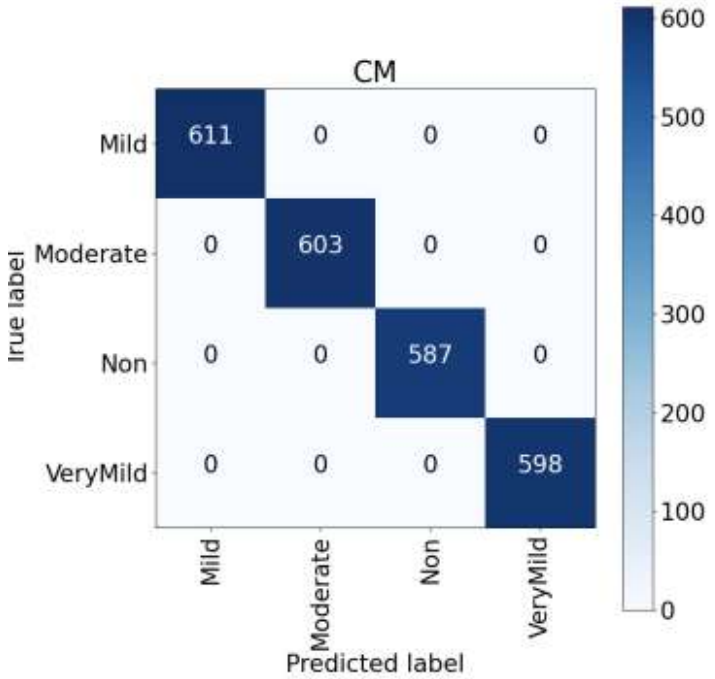


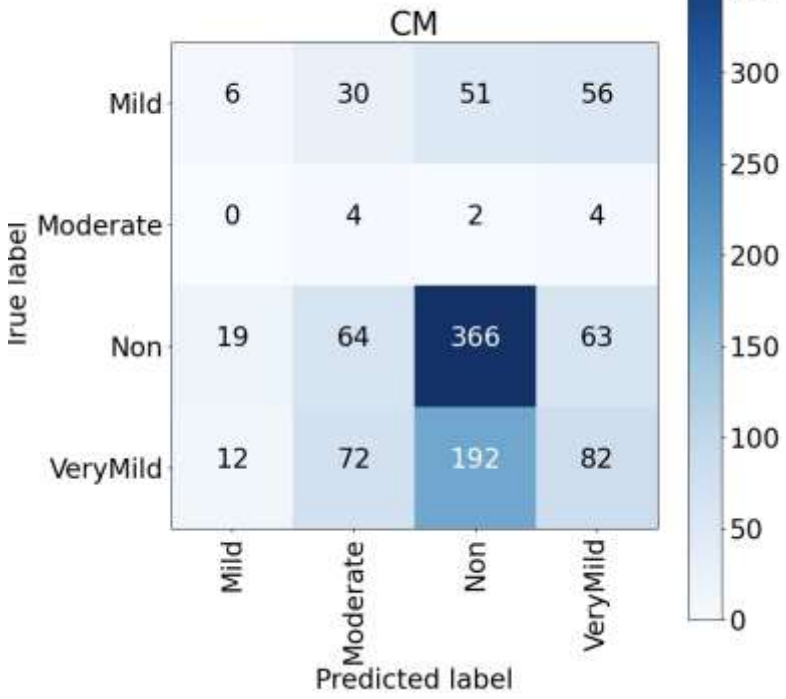


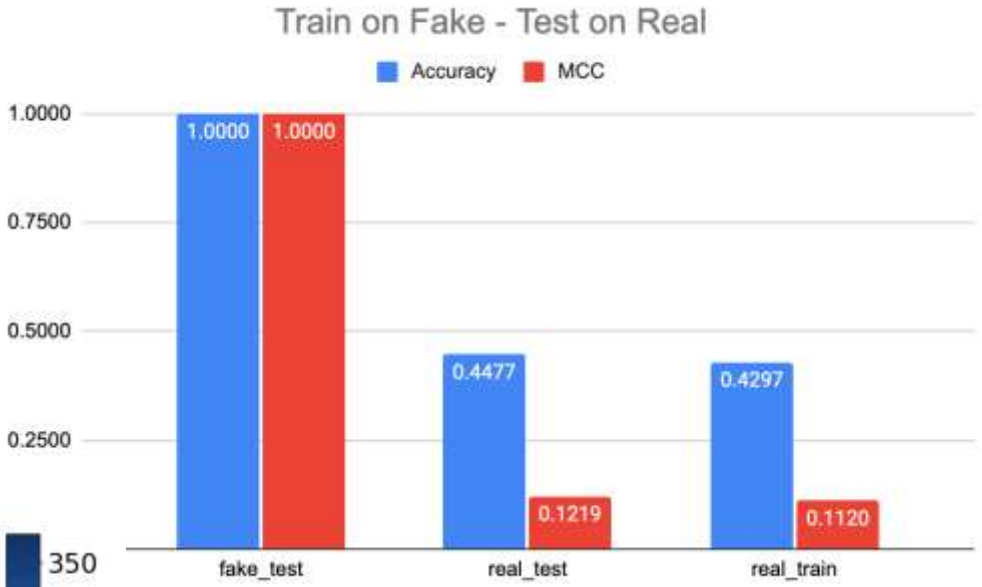


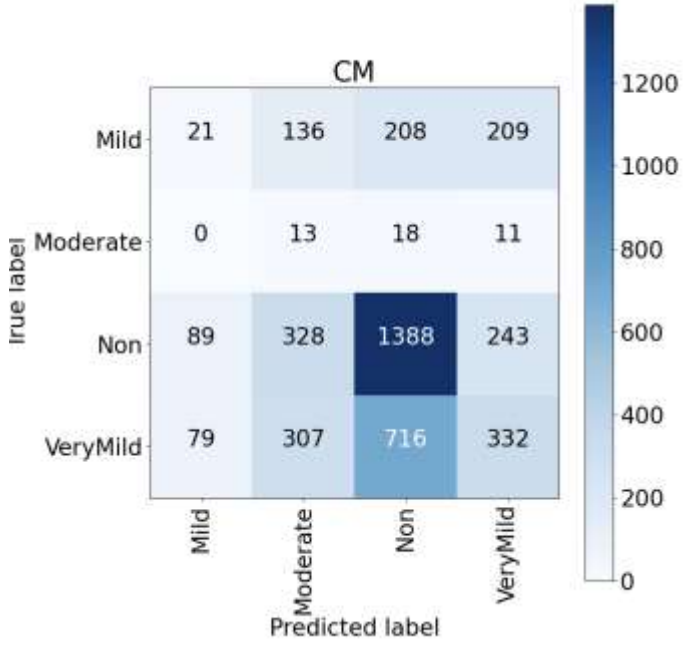


Trained on synthetic dataset and performance evaluated on real dataset

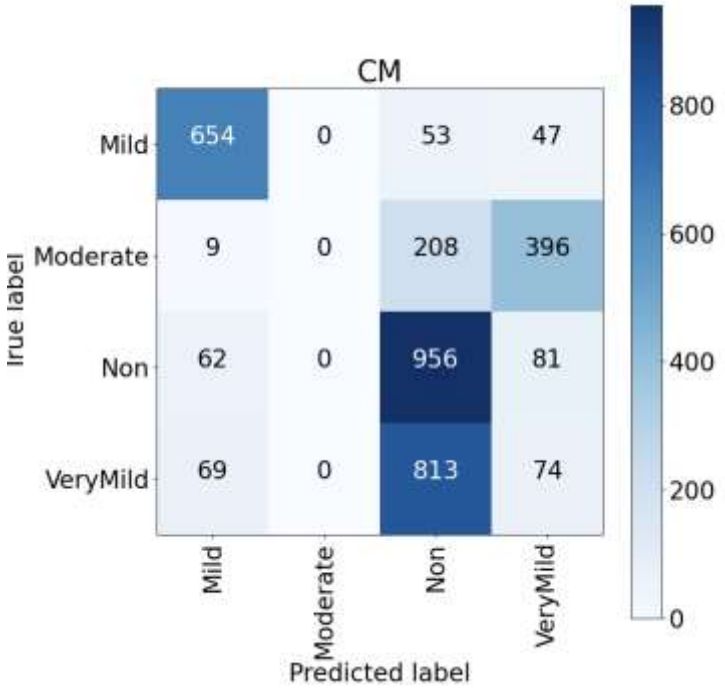


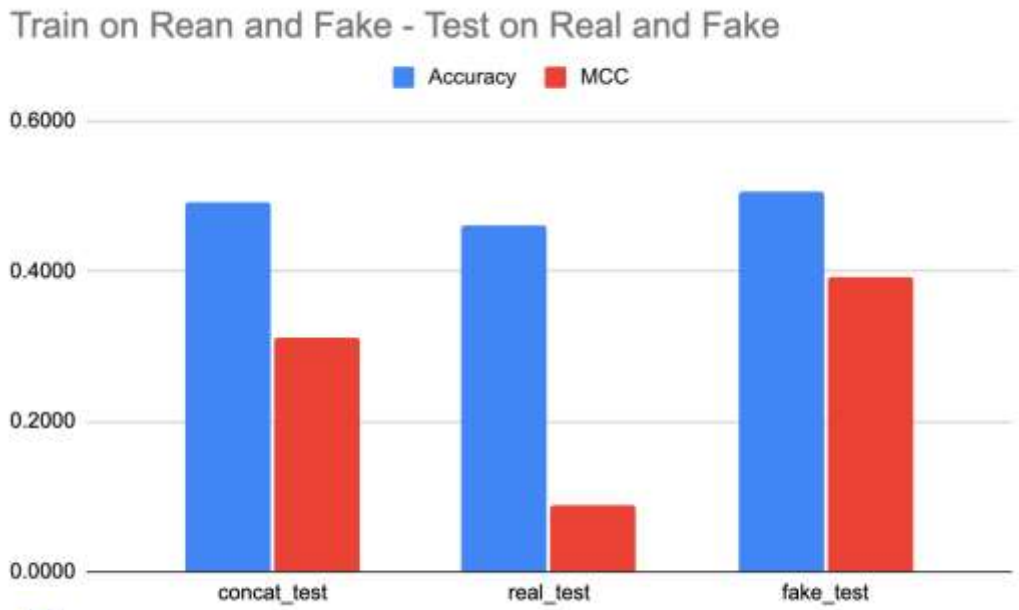


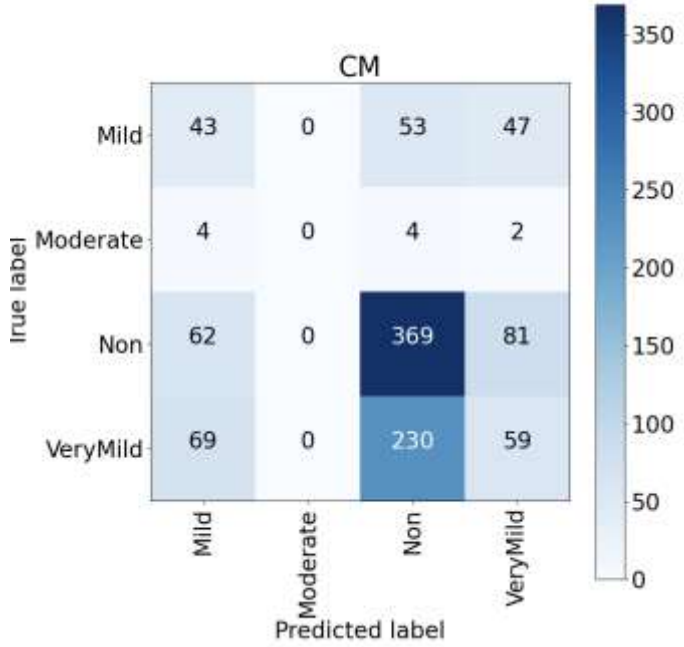


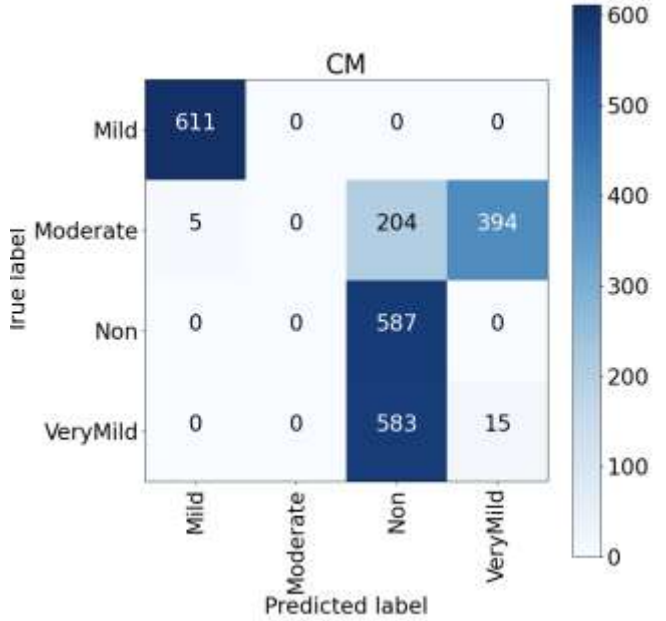


Trained on combined datasets and performance evaluated on real and synthetic dataset

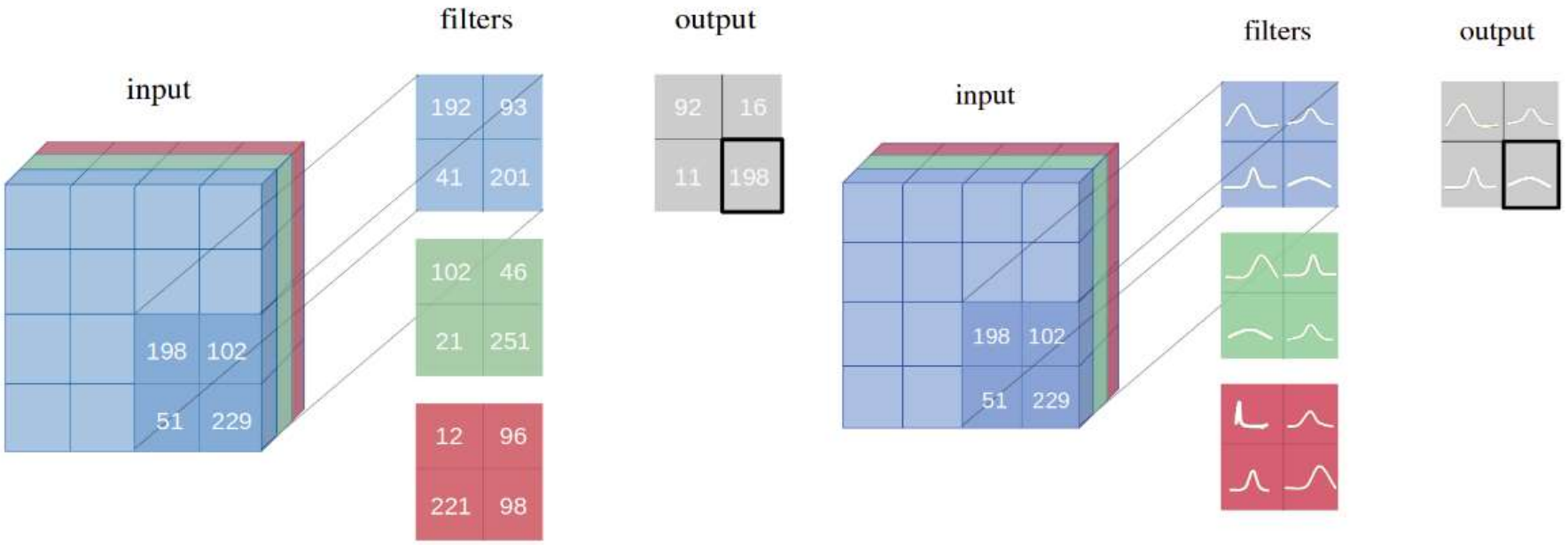






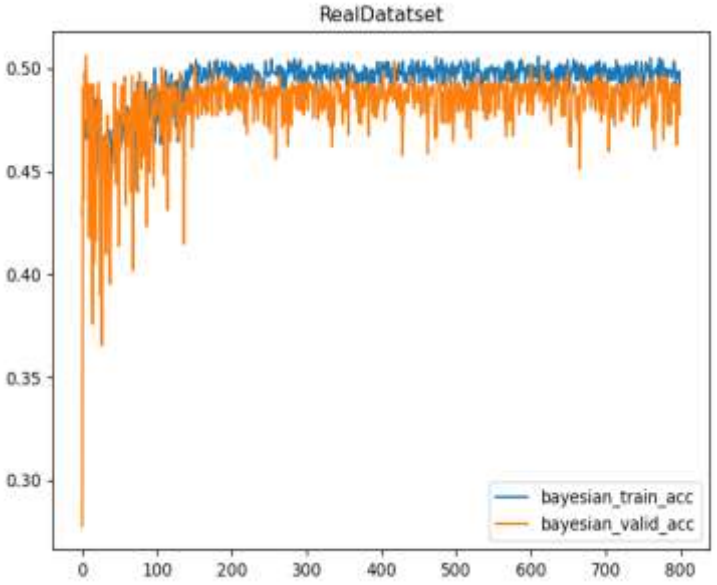


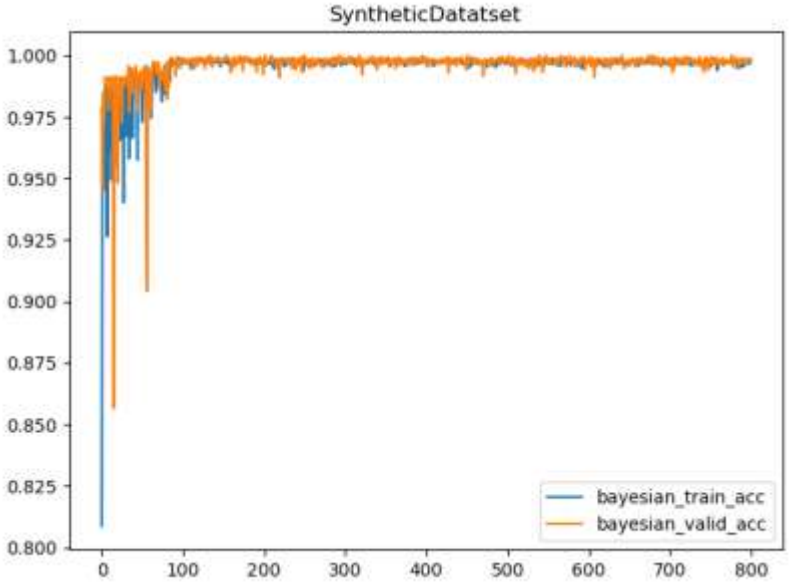
Bayesian Convolutions

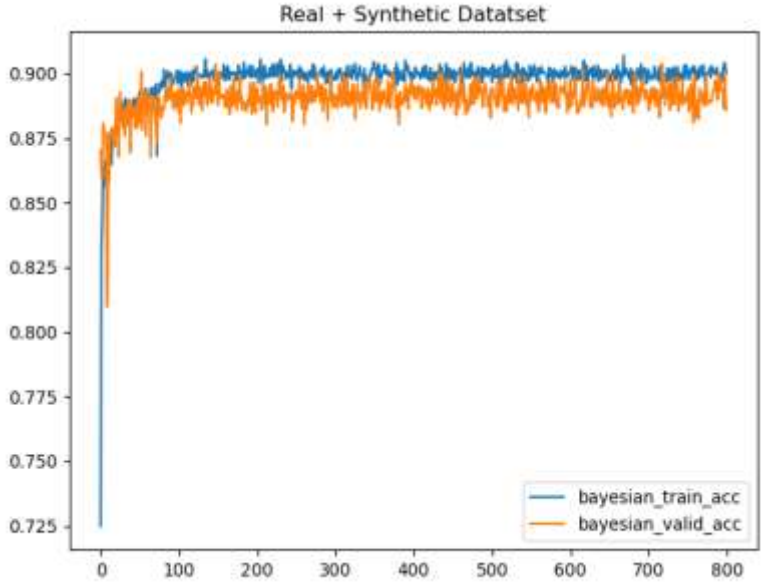


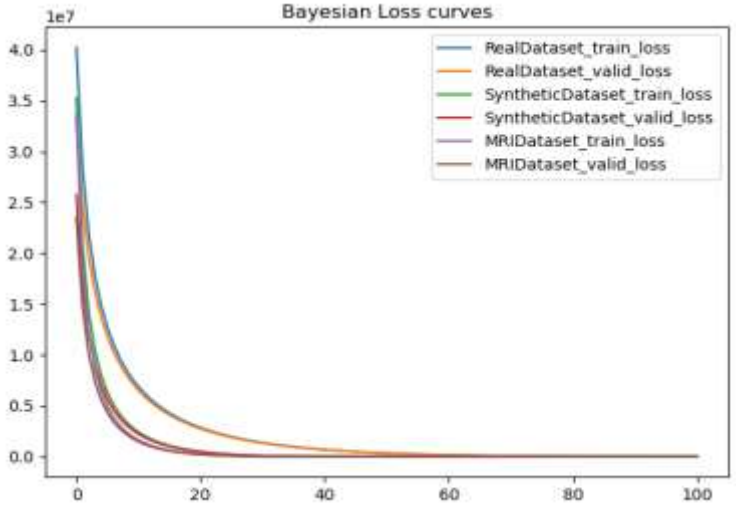
Reference: https://arxiv.org/abs/1901.02731

Bayesian AlexNet



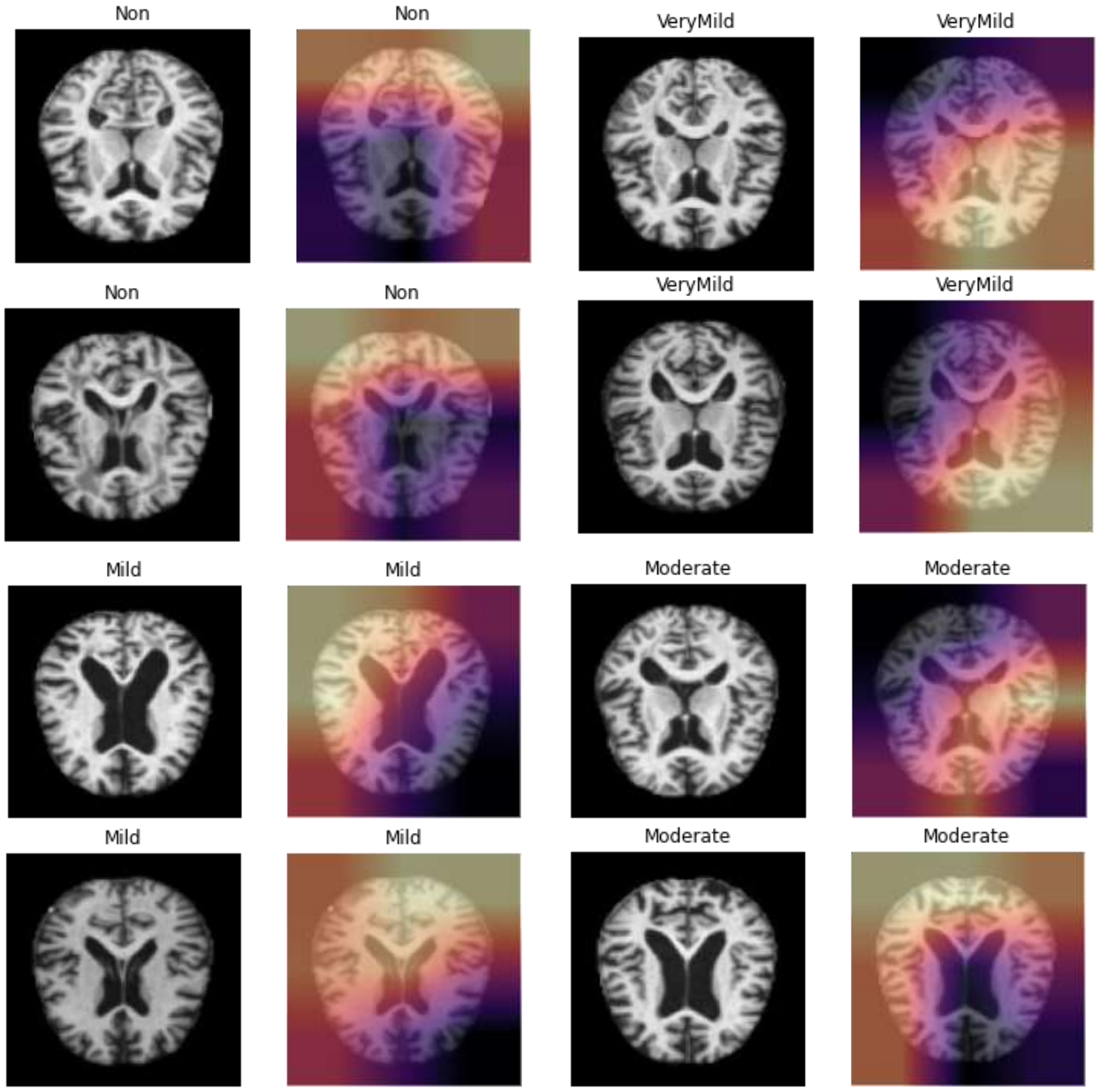




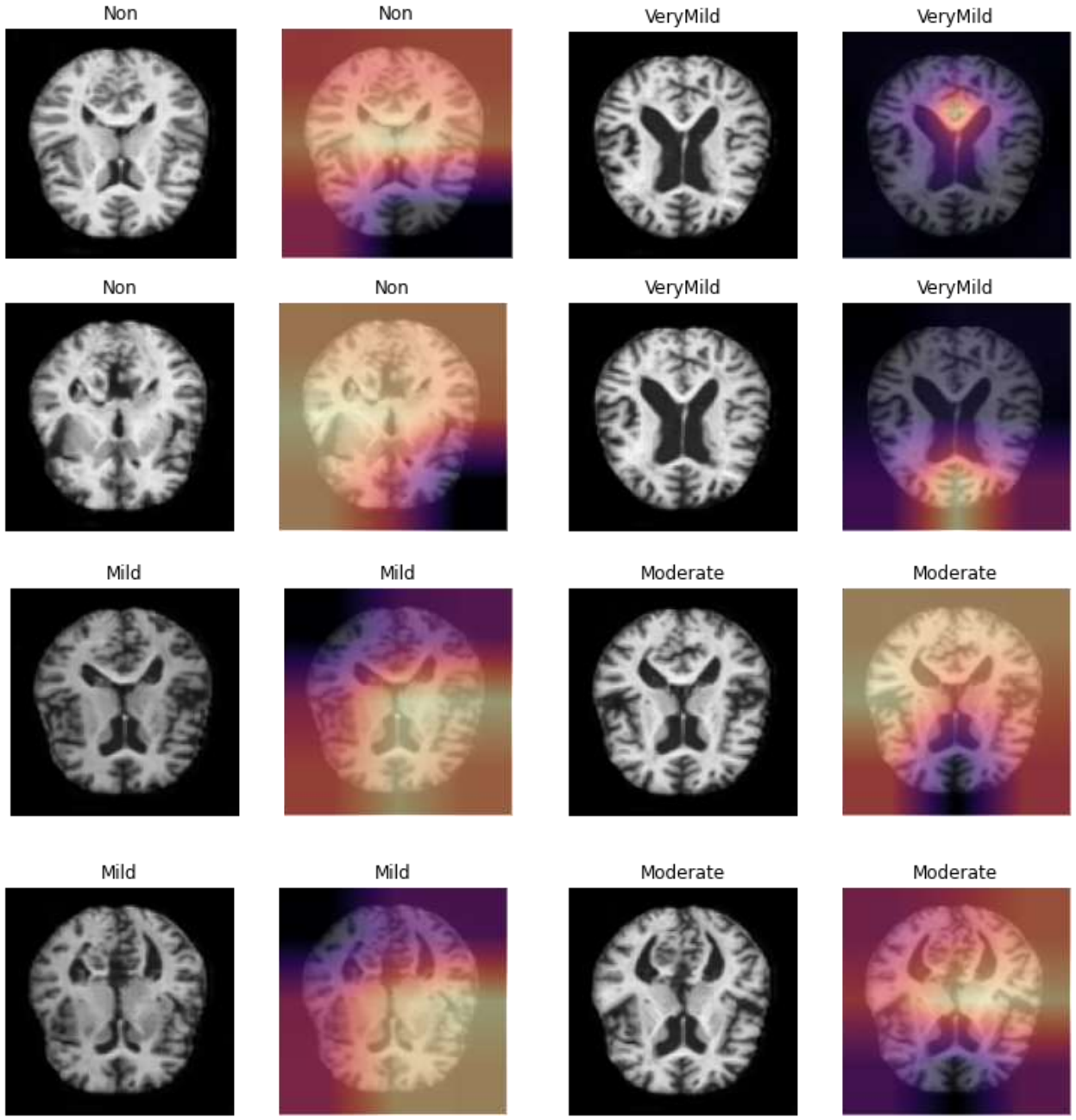


Metrics evaluation

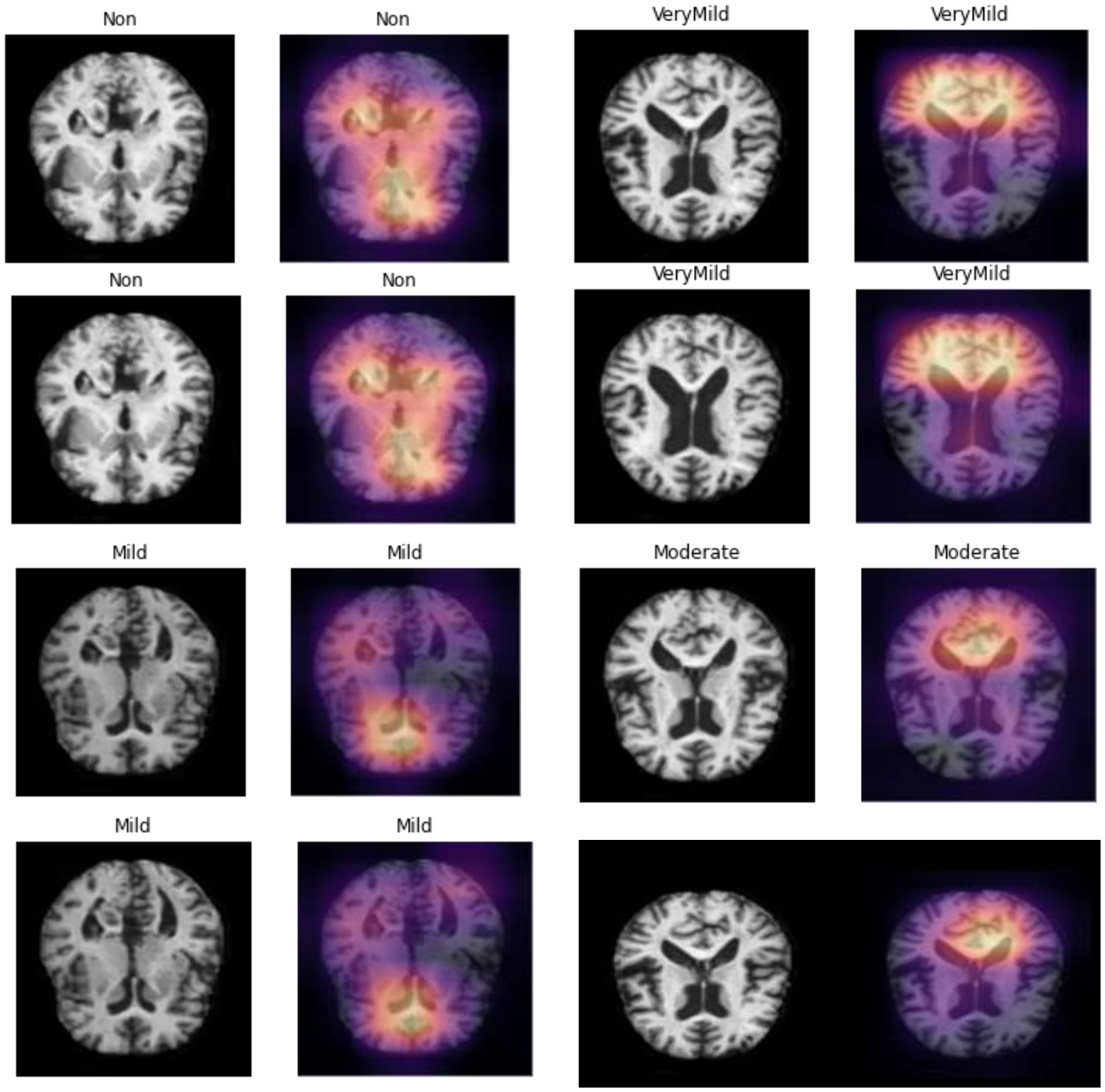
Training (Train and valid set)	*Performance evaluation (Test set)*	*Precision*		*Recall*		*F-Score*		*Accuracy*
		Macro	*Weighted*	*Macro*	*Weighted*	*Macro*	*Weighted*	
RealData	RealData	0.46	0.51	0.25	0.50	0.18	0.35	48.07 ± 0.024
	SyntheticData	0.20	0.36	0.25	0.50	0.18	0.35	49.52 ± 0.024
	CombinedData	0.21	0.37	0.25	0.50	0.18	0.35	49.51 ± 0.012
SyntheticData	RealData	0.31	0.49	0.49	0.41	0.28	0.43	39.81 ± 0.015
	SyntheticData	0.97	1.00	0.97	1.00	0.97	1.00	**99.72 ± 0.023**
	CombinedData	0.64	0.85	0.75	0.82	0.66	0.83	82.29 ± 0.003
CombinedData	RealData	0.40	0.58	0.38	0.55	0.38	0.55	54.26 ± 0.029
	SyntheticData	0.94	0.99	0.79	0.99	0.81	0.99	98.98 ± 0.002
	CombinedData	0.63	0.85	0.63	0.85	0.63	0.85	85.66 ± 0.084



Real Dataset

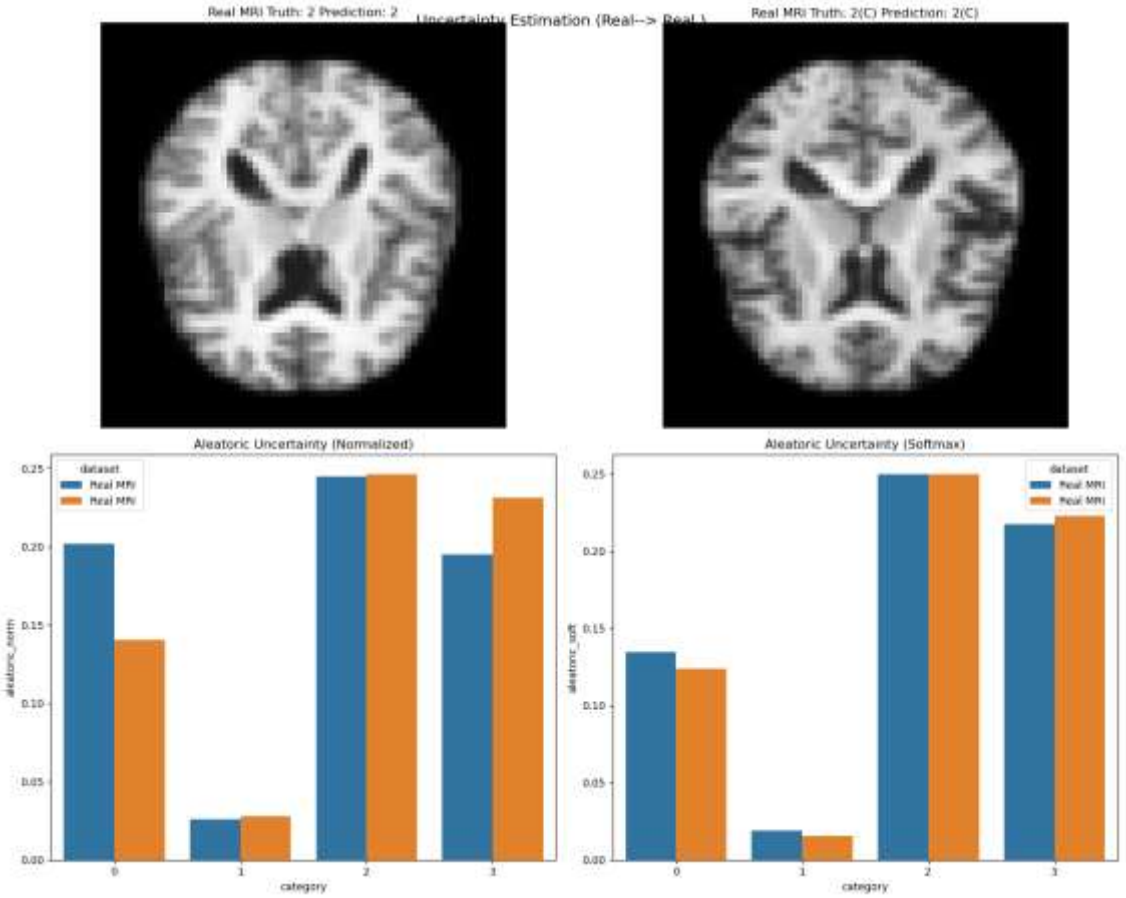


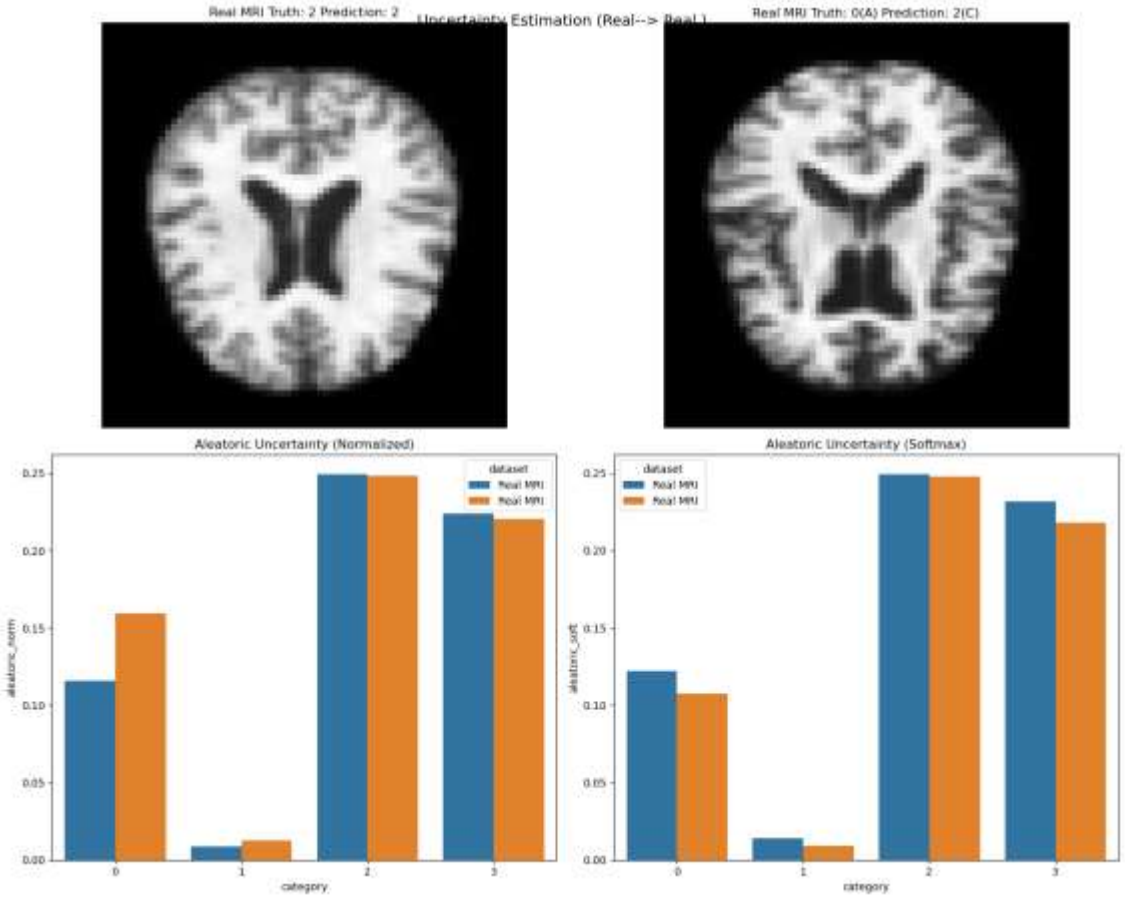
Synthetic dataset



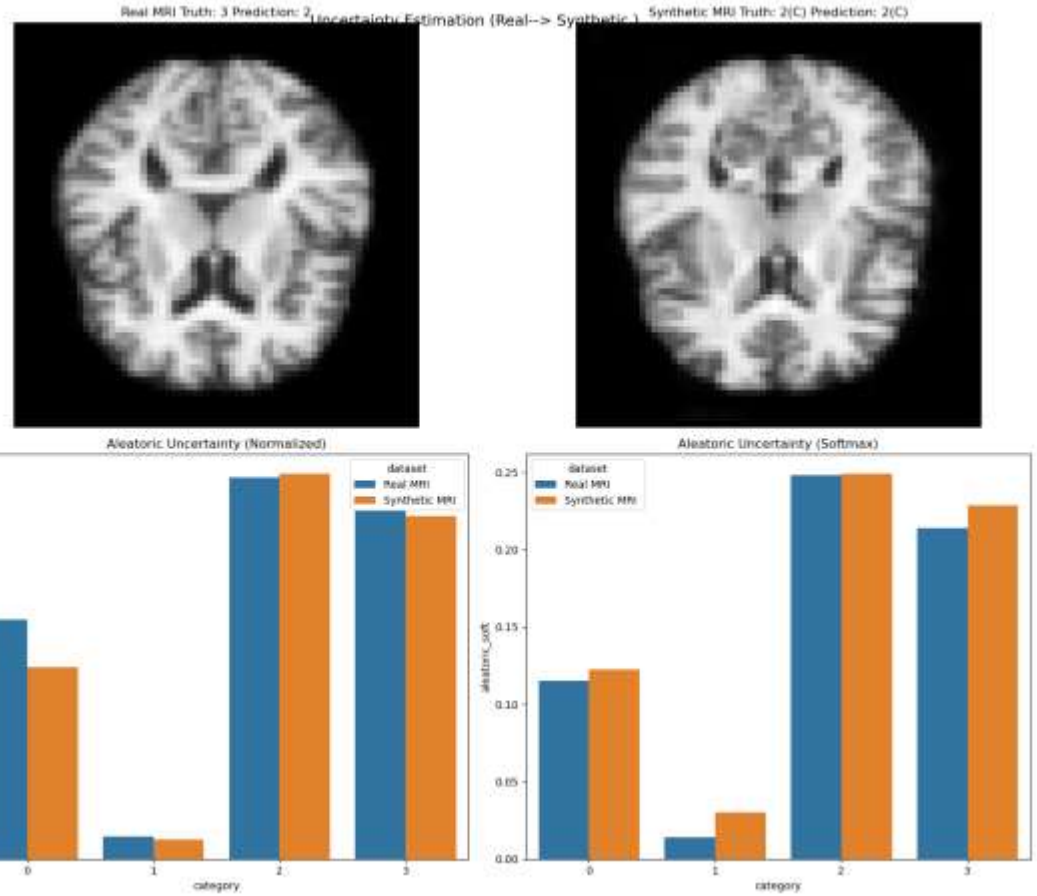
Combined dataset

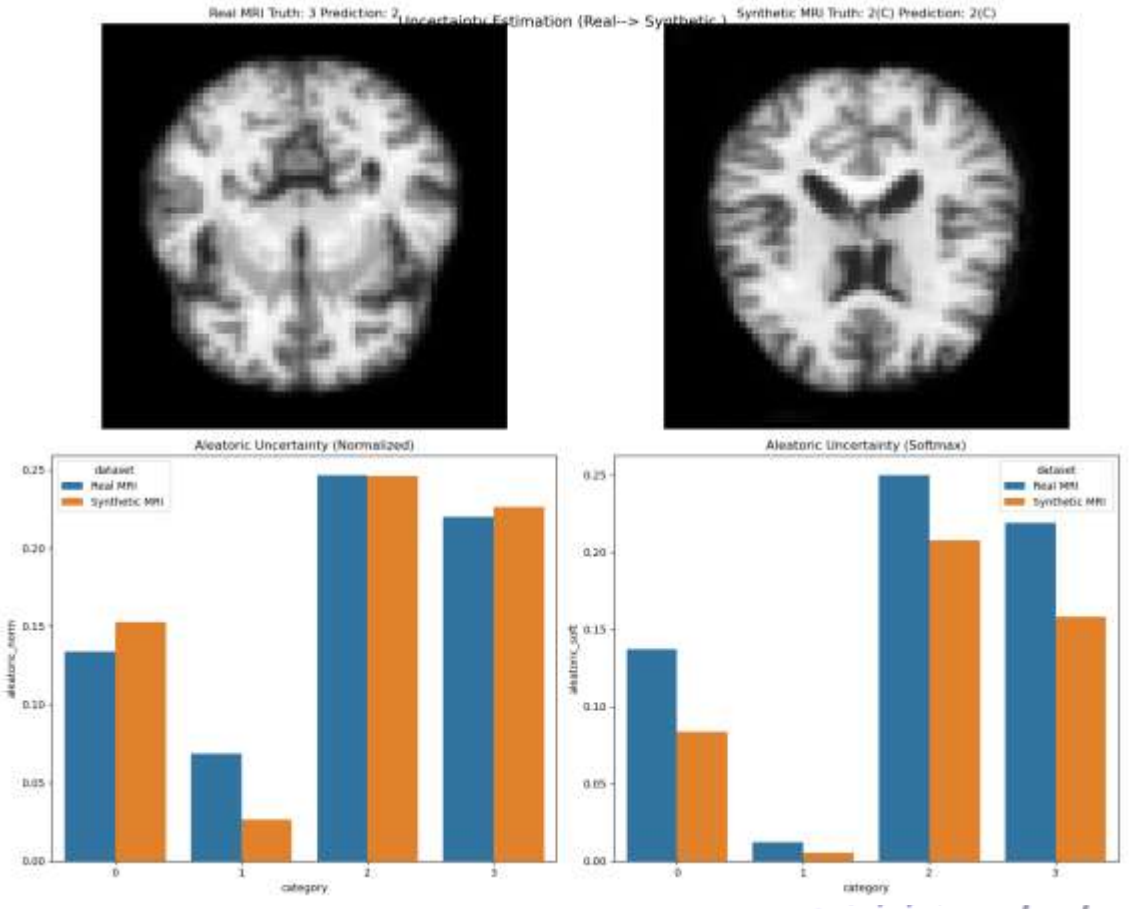
Data Uncertainity b/w Real and Real



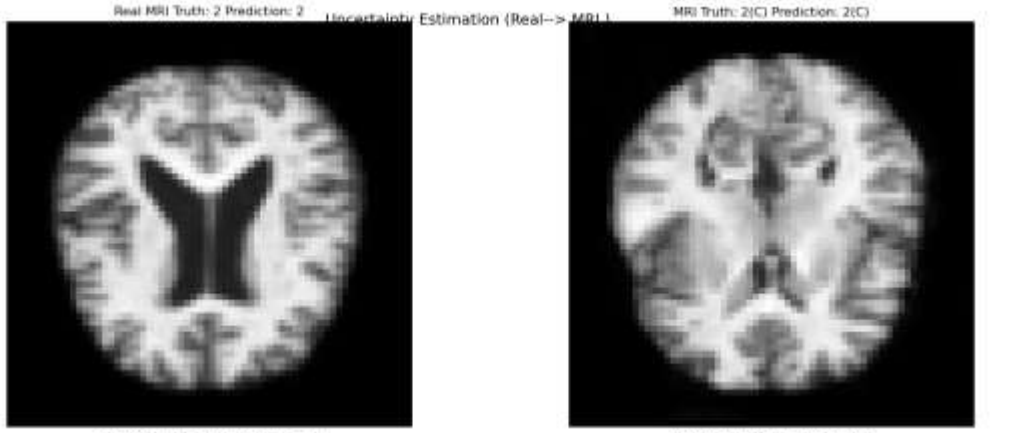


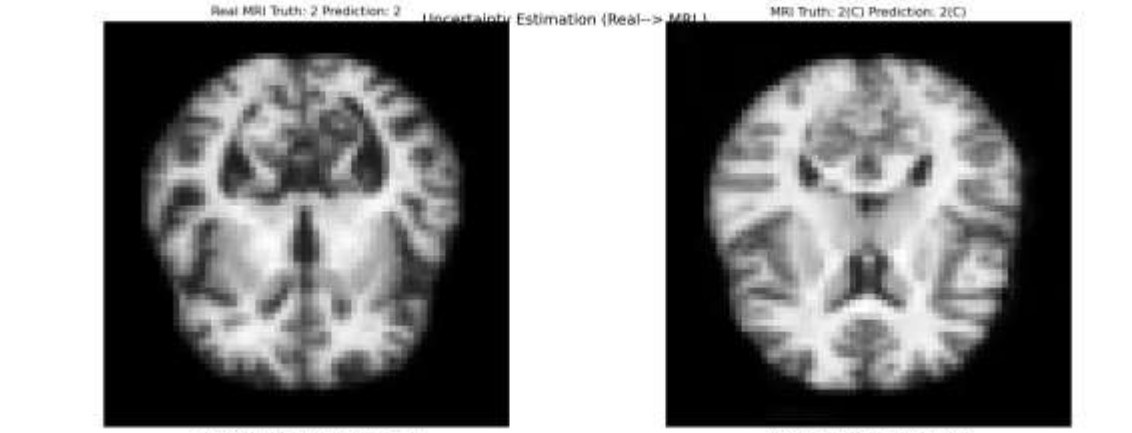
Data Uncertainity b/w Real and Synthetic



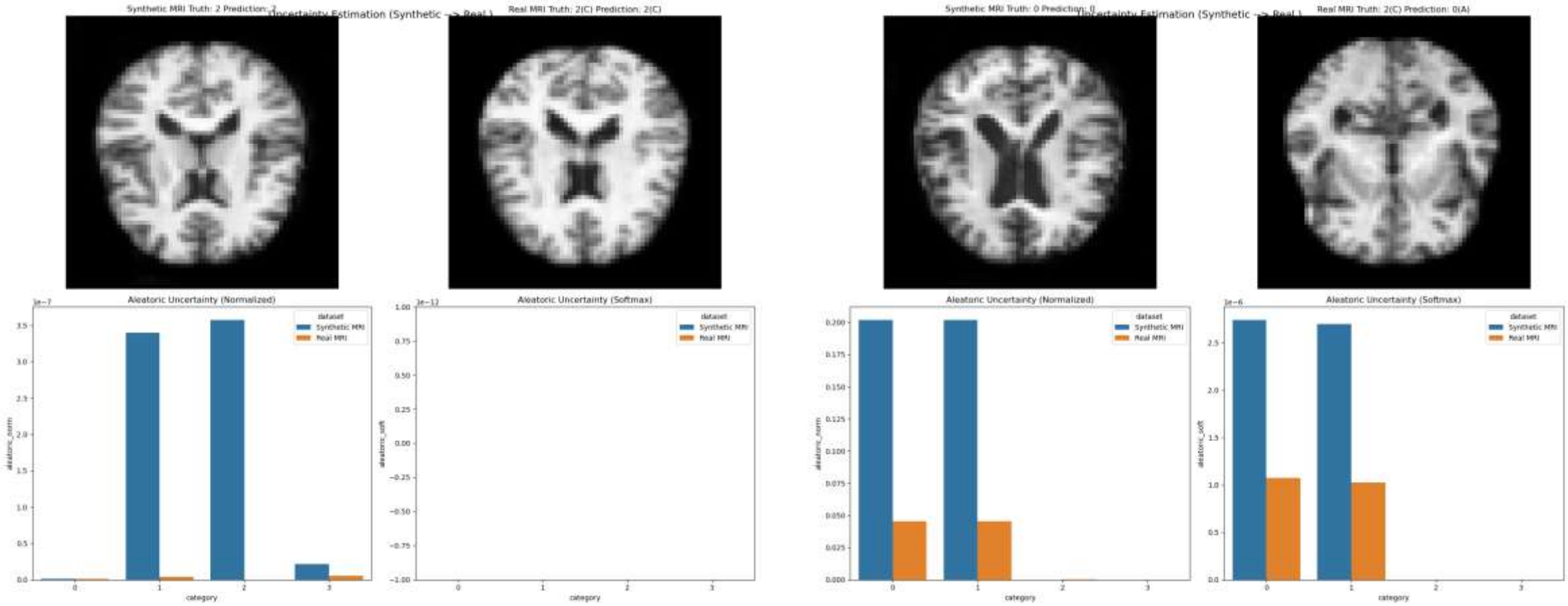


Data Uncertainity b/w Real and Combined





Data Uncertainity b/w Synthetic and Real



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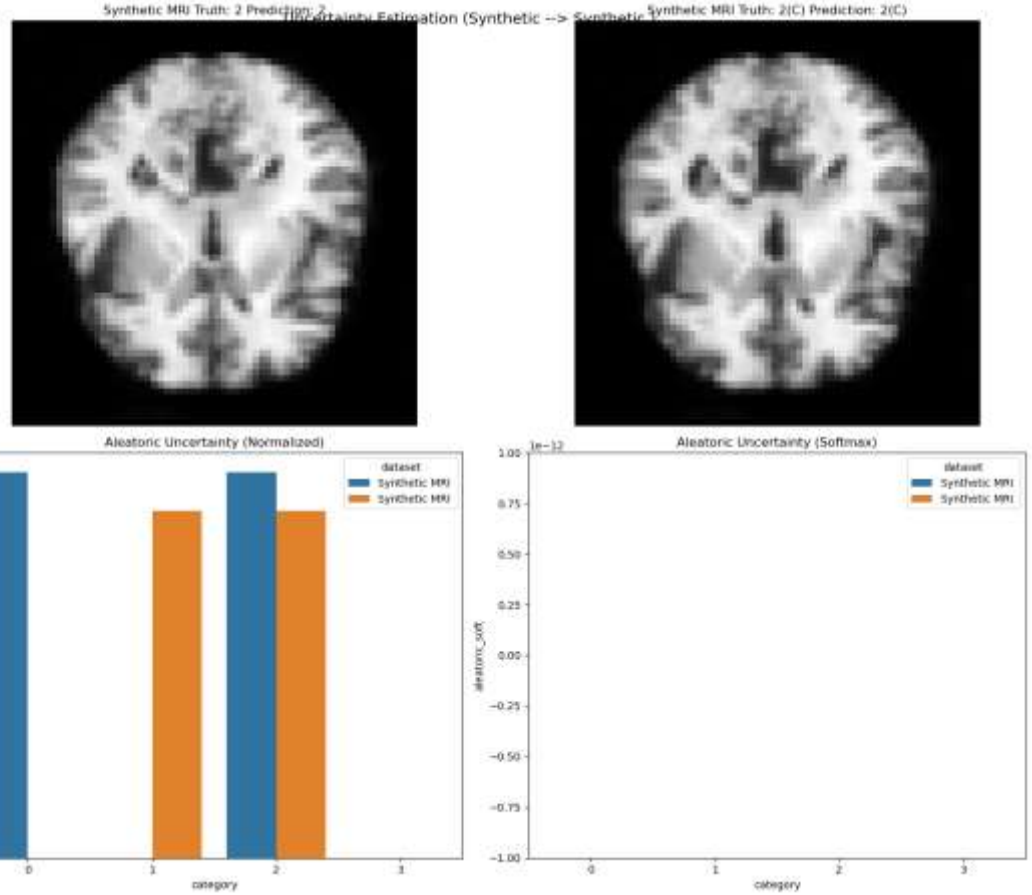
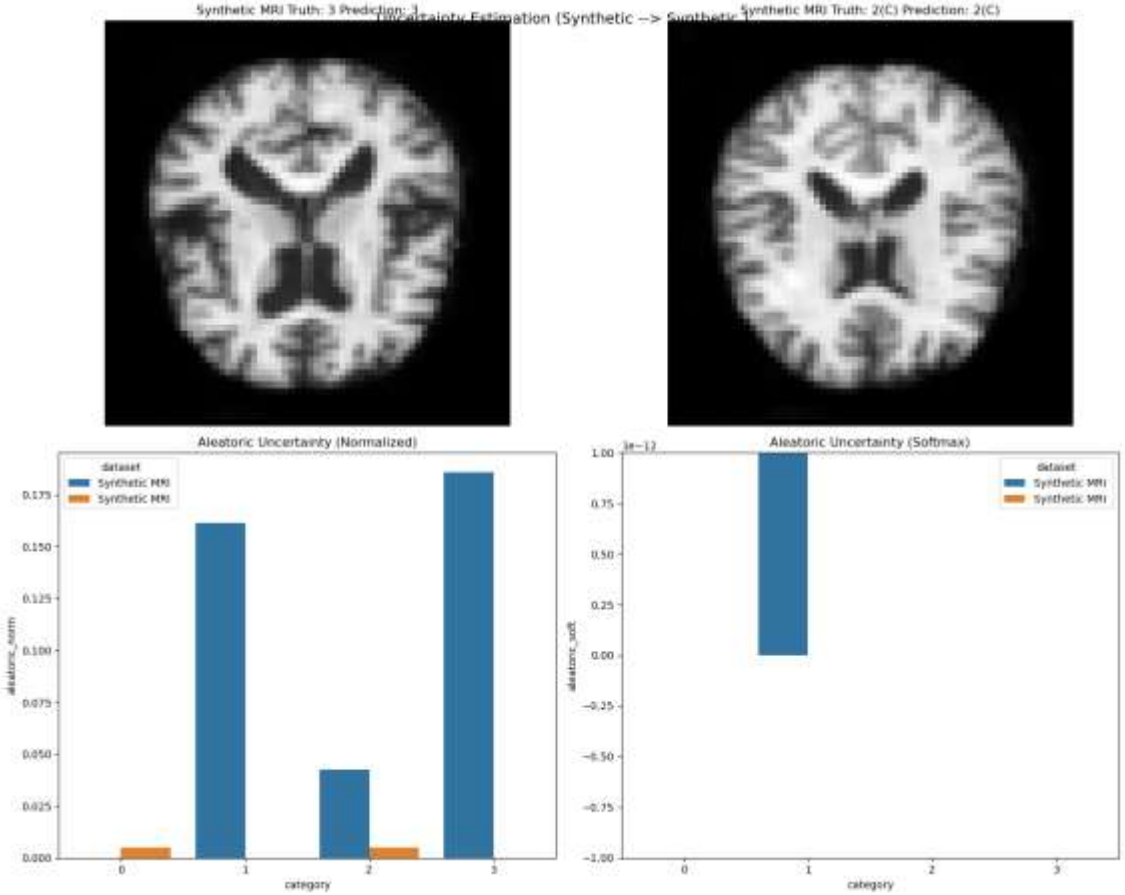
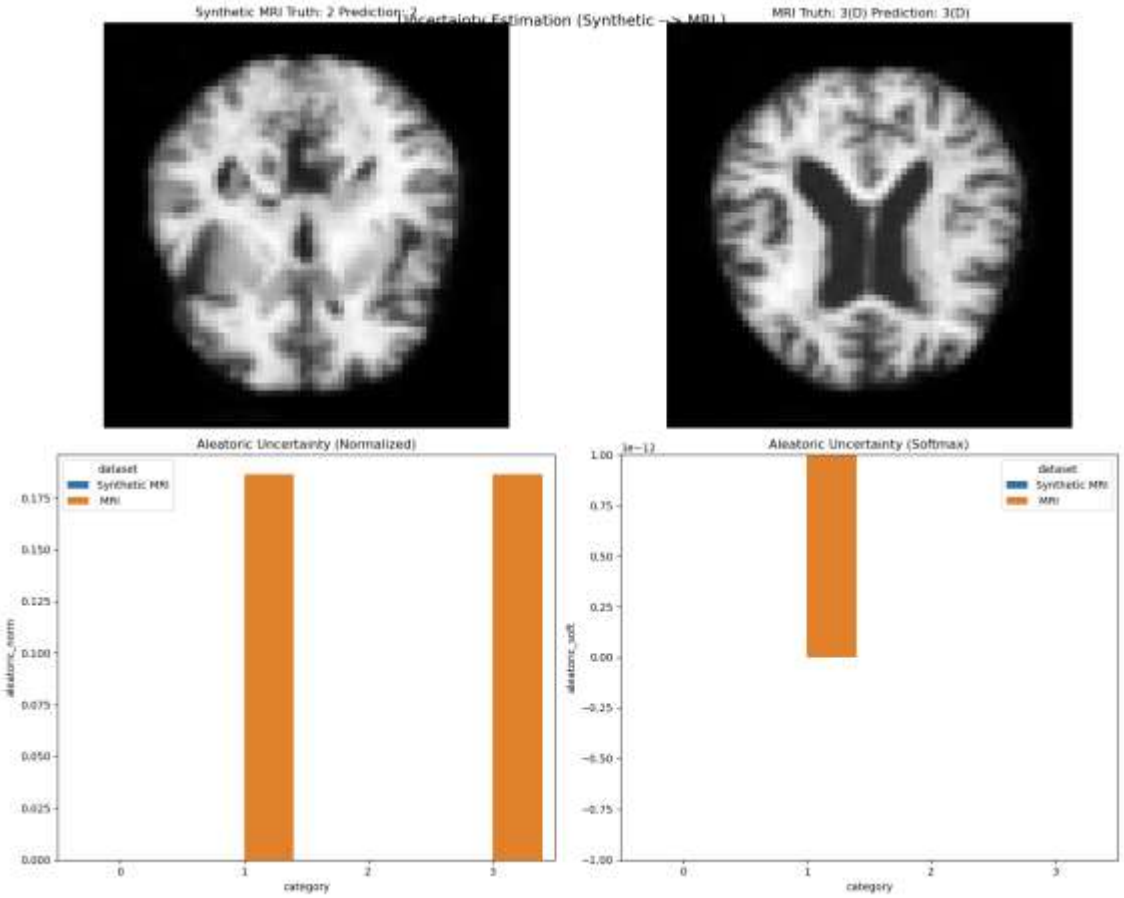
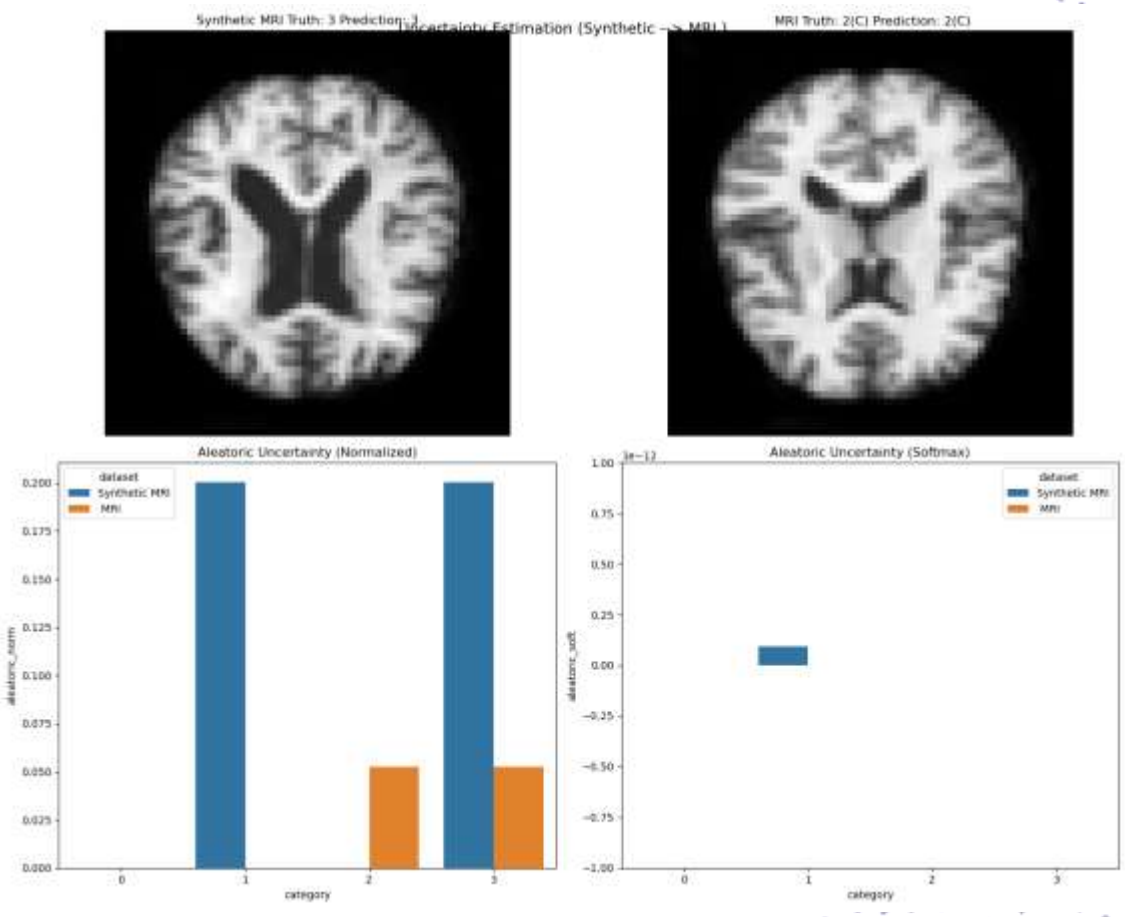


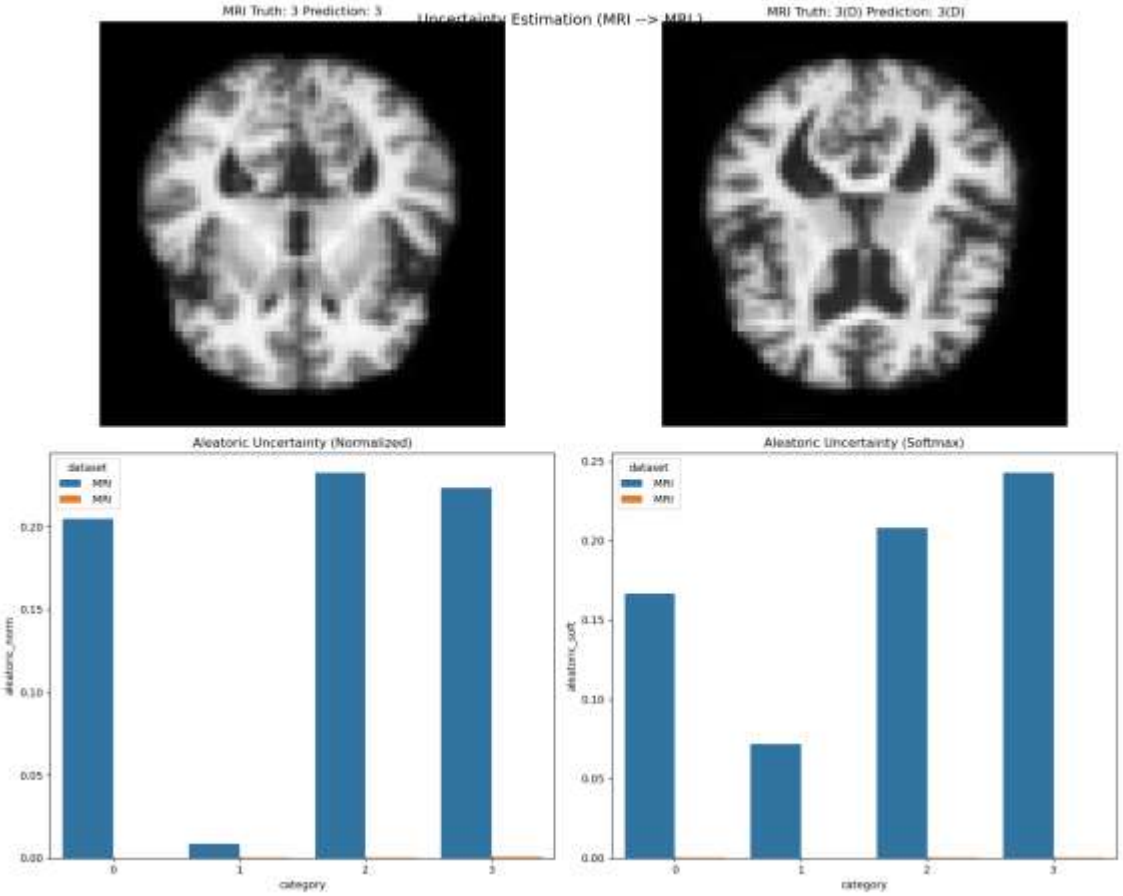


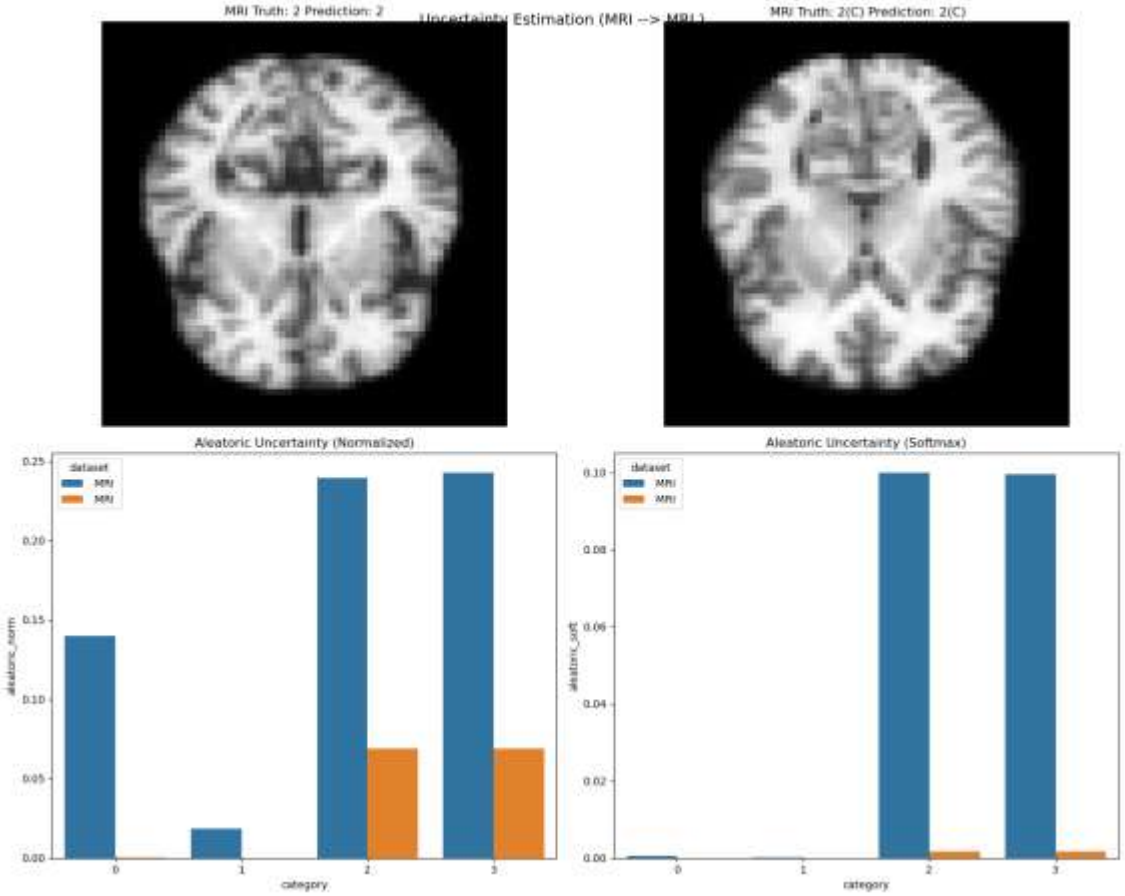
Data Uncertainity b/w Synthetic and Combined



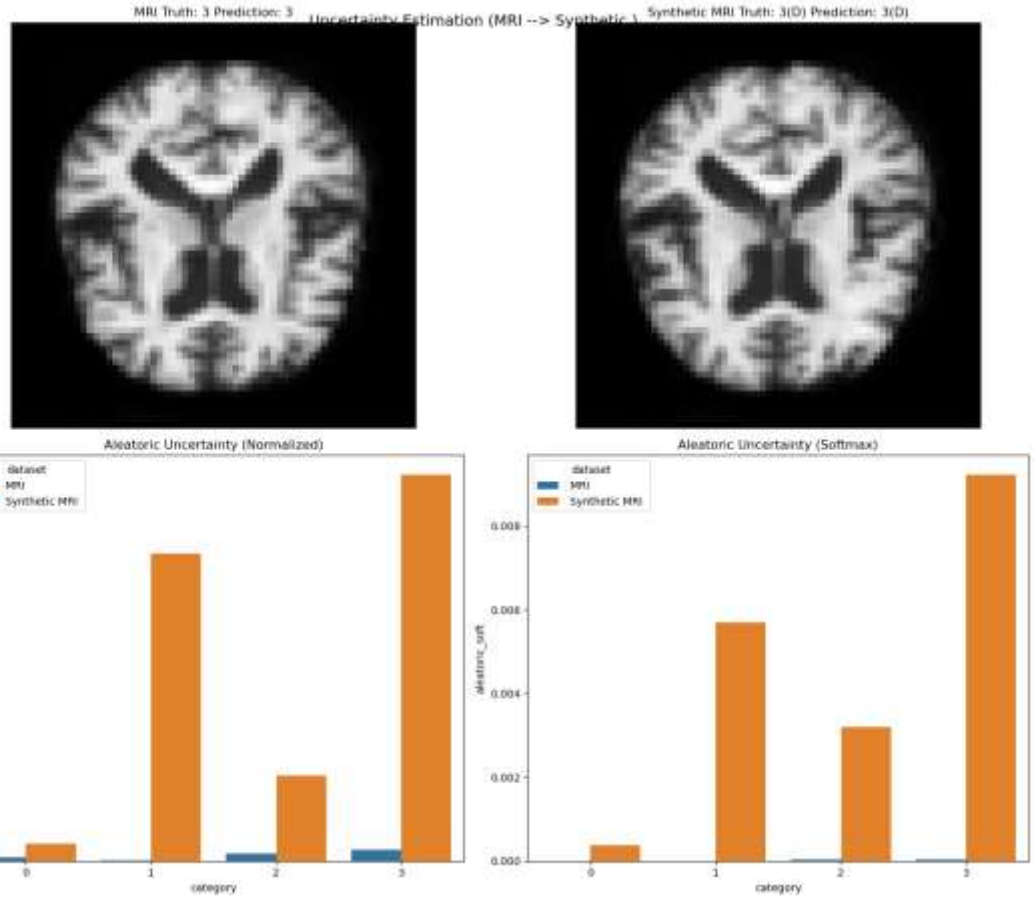


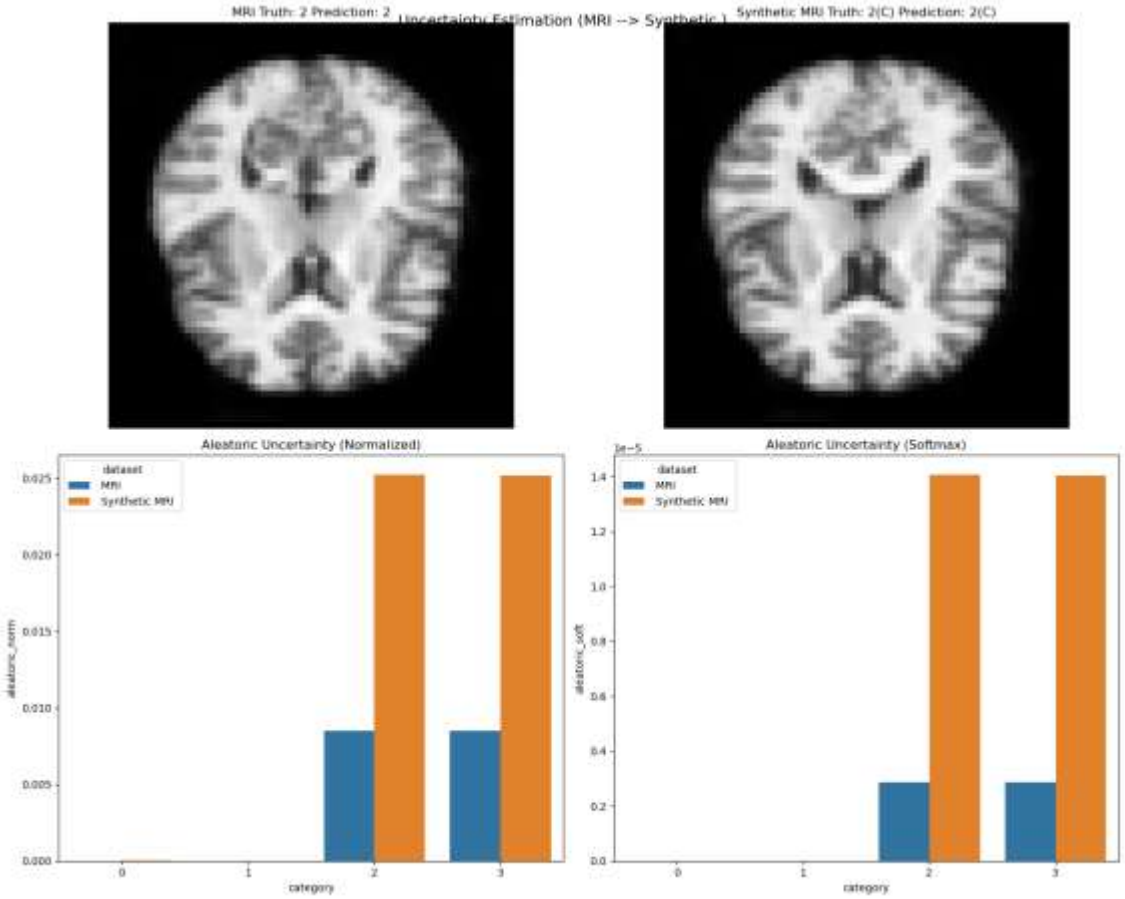
Data Uncertainity b/w combined and combined



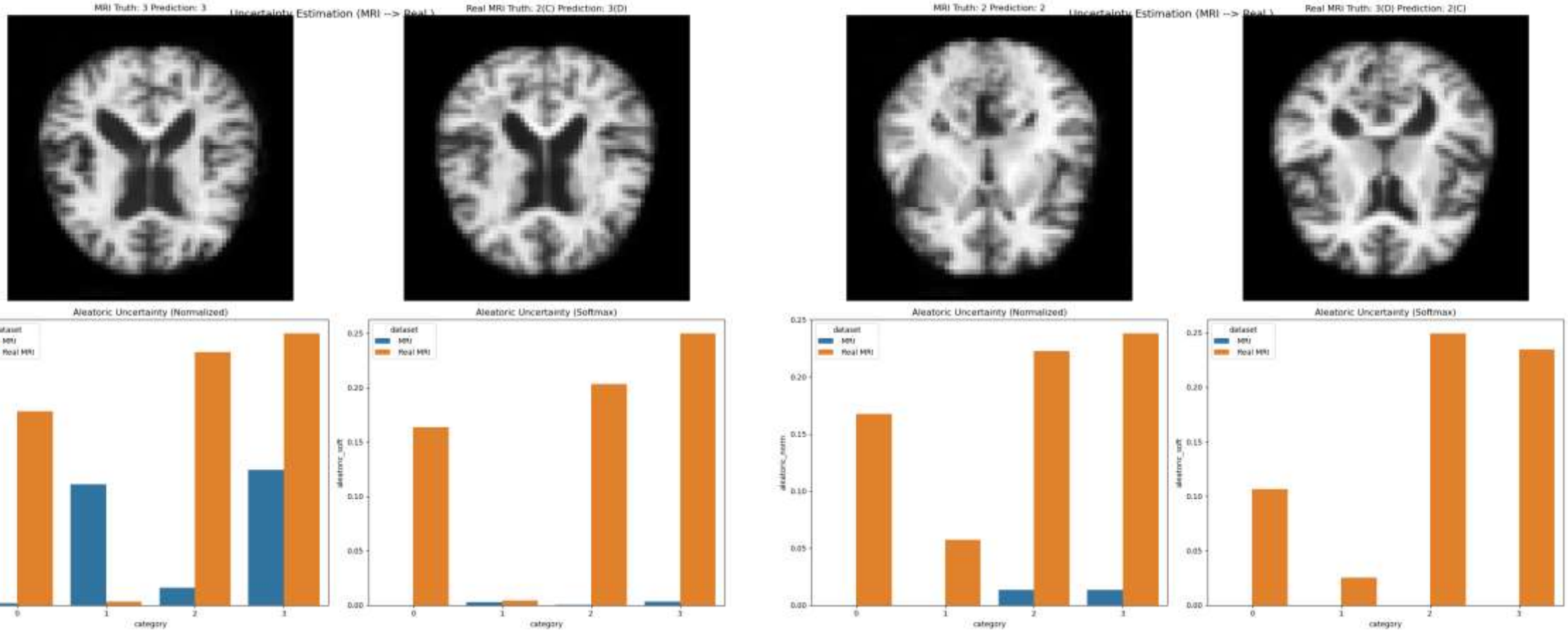


Data Uncertainity b/w Combined and Synthetic



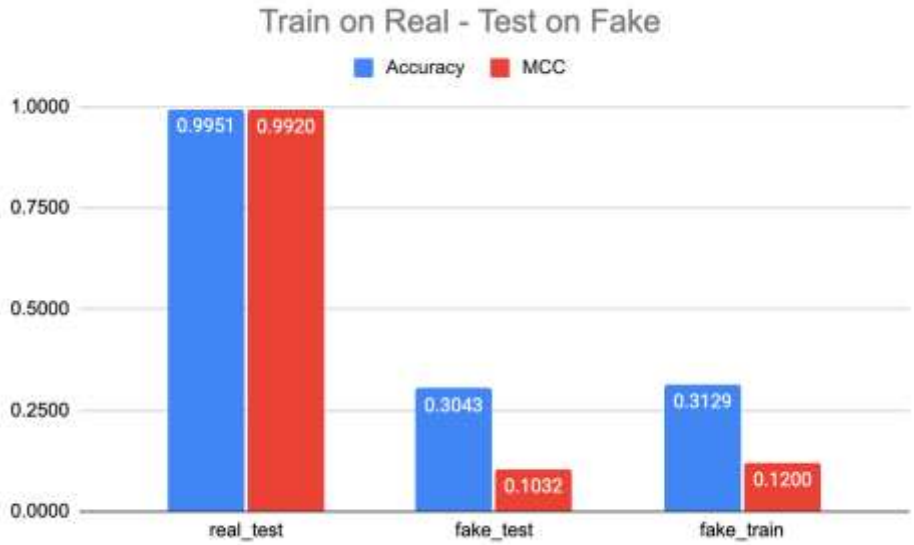


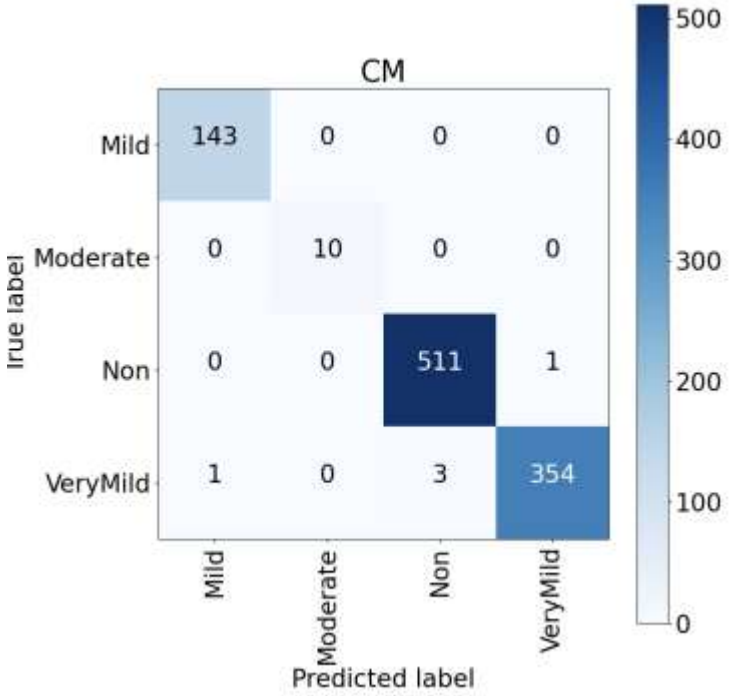
Data Uncertainity b/w combined and real

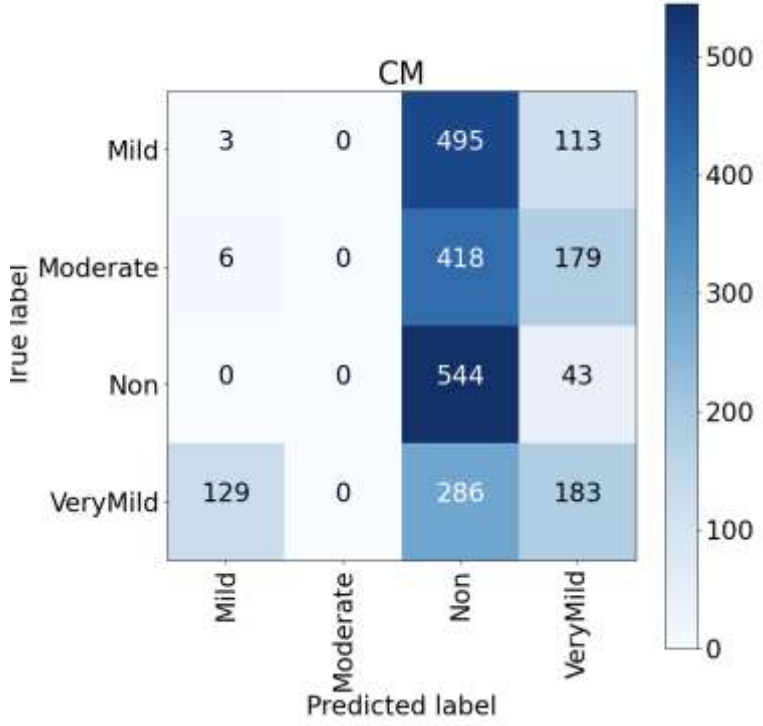


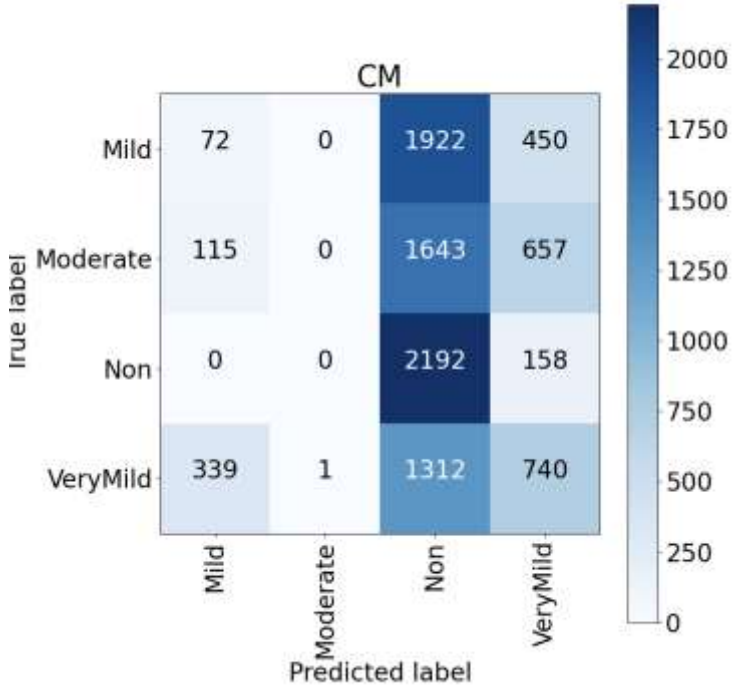
ResNet-151

Train on Real – Test on Fake

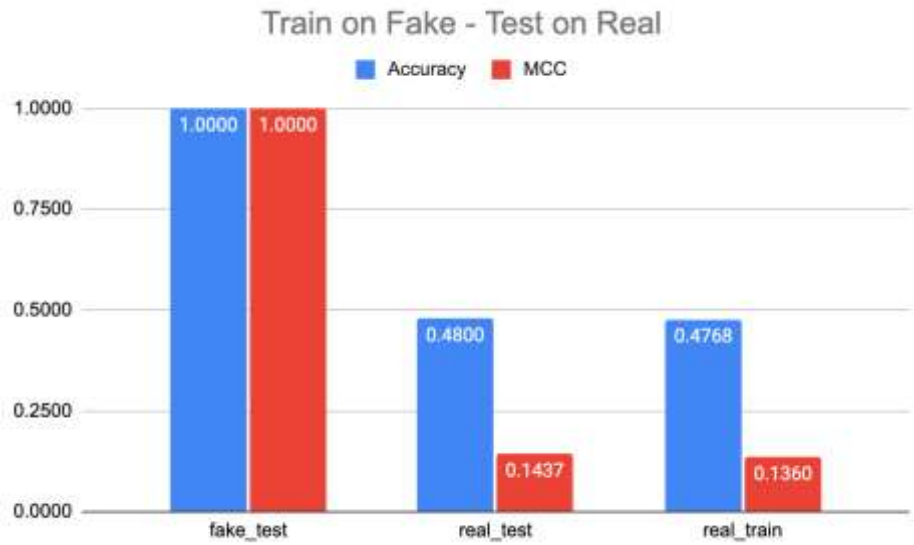


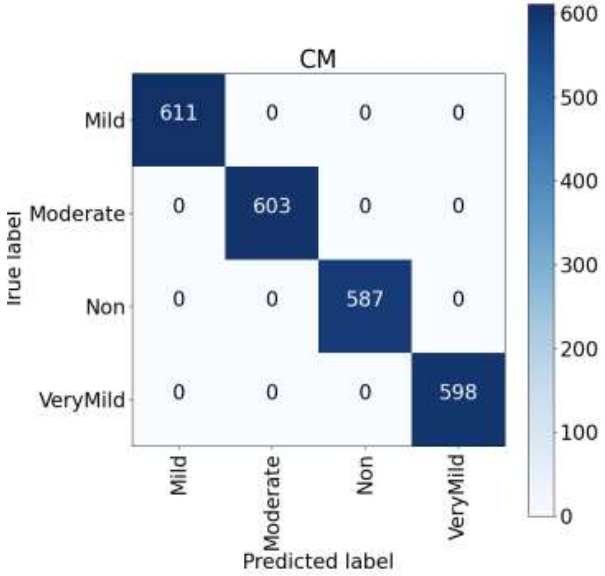


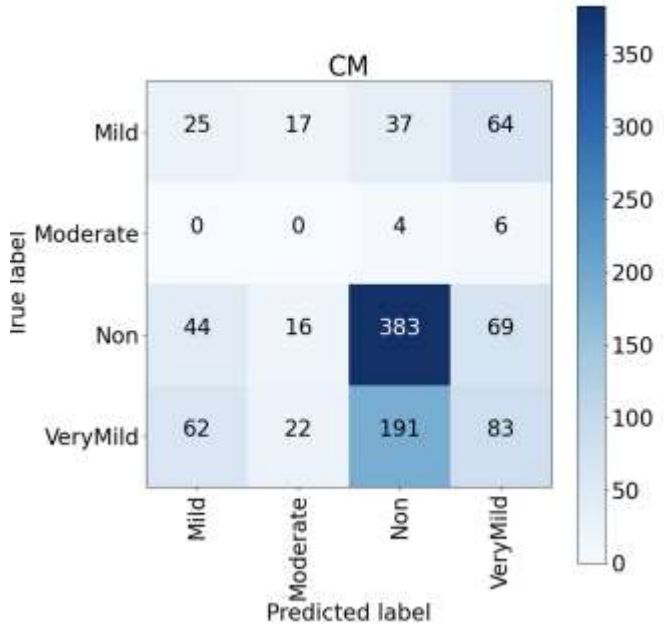


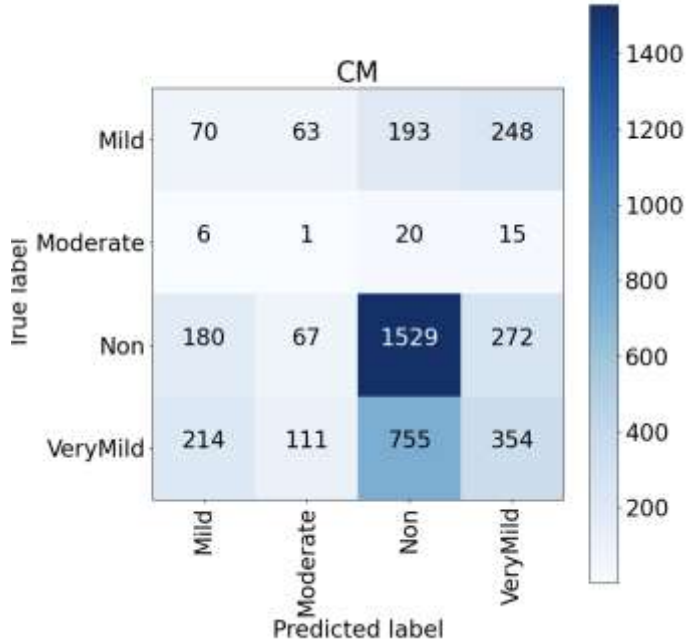


Train on Fake – Test on Real

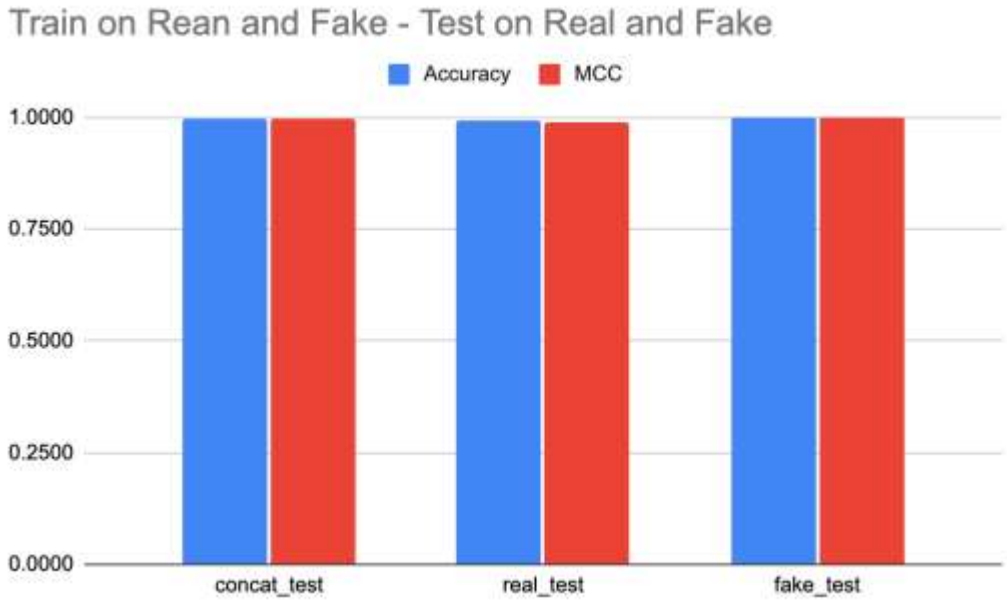


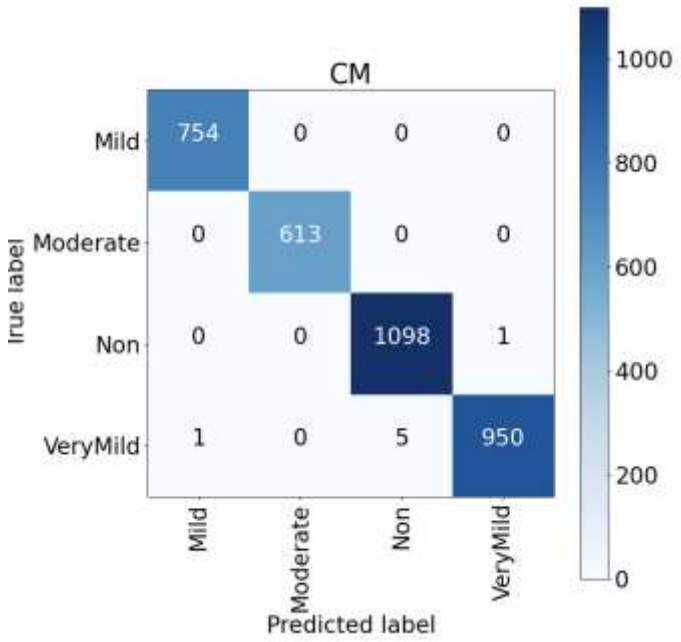


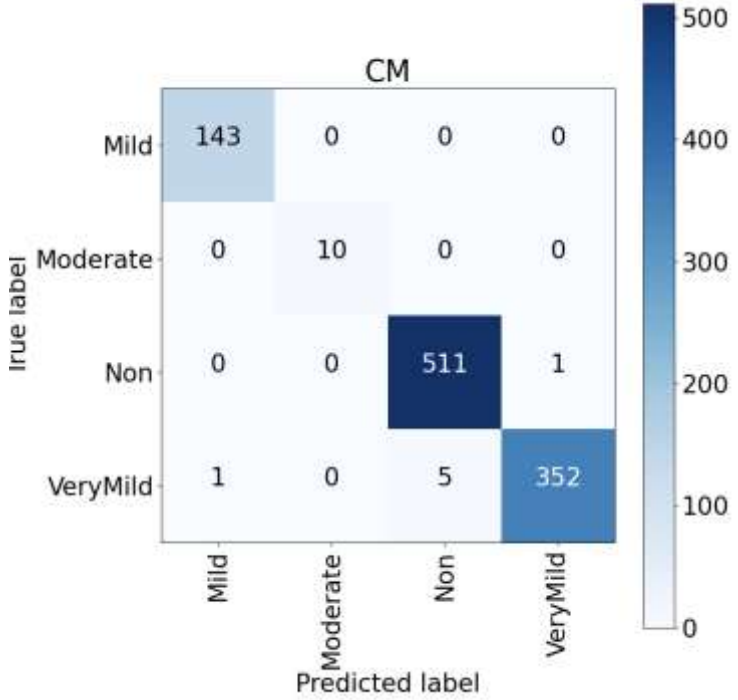


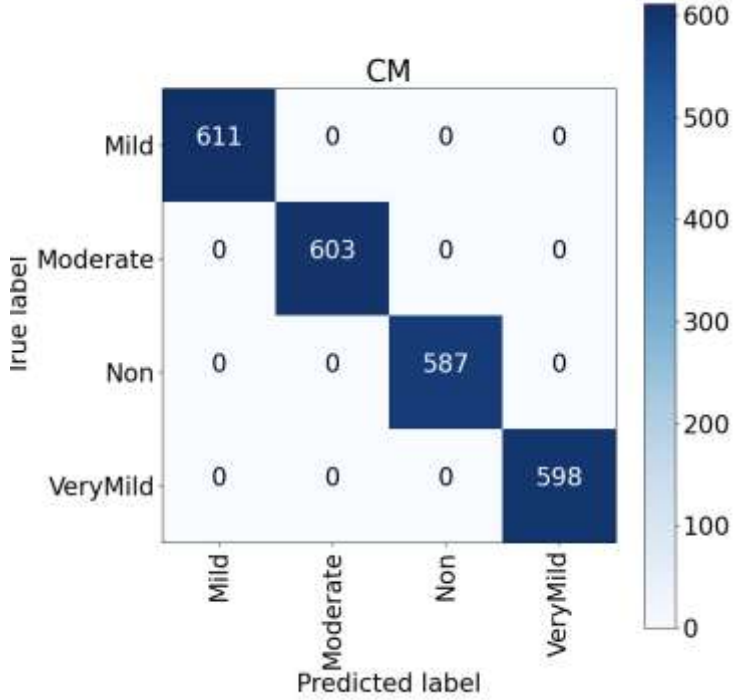


Train on R and F – Test on R and F









Thank You

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