ISTANBUL TECHNICAL UNIVERSITY
FACULTY OF COMPUTER AND INFORMATICS

Computer Engineering Graduation Project Presentation

PERFORMANCE ANALYSIS OF DEEPFAKE DETECTION USING DIFFERENT FACIAL REGIONS

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Introduction

What is deepfake?

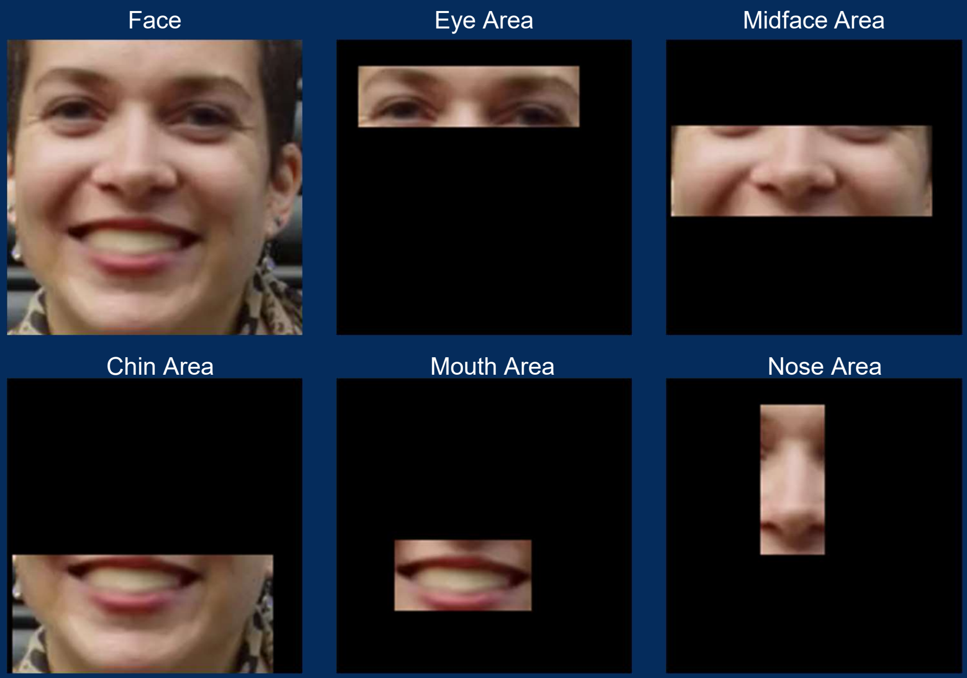
- Deepfake is visual data that created using the deep learning to replace human faces inside the video or image with another face within the video or image. The name deepfake comes from the combination of the terms “deep learning” and “fake”.

Example deepfake images from Celeb-DF [1] Dataset. Left image is the original image and others are Deepfakes generated different donor subjects.

[1] Y. Li, P. Sun, H. Qi and S. Lyu, "Celeb-DF: A Large-scale Challenging Dataset for DeepFake Forensics," in IEEE Conference on Computer Vision and Patten Recognition (CVPR), Seattle, WA, United States, 2020.

Problem Statement

Comparing deepfake detection performances of models by using different facial regions.



Images: A. Rössler, D. Cozzolino, L. Verdoliva, C. Riess, J. Thies and M. Nießner, "FaceForensics++: Learning to Detect Manipulated Facial Images," in ICCV, 2019.

Dataset

	Image Count			
	planned		actual	
	manipulated	original	manipulated	original
Train	12544	14410	12048	13732
Validation	3150	3610	3061	3447
Test	3934	4510	3746	4283

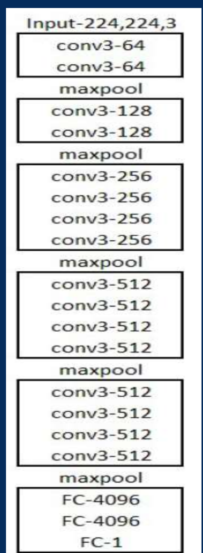
Dataset of train, validation and test splits

Dataset	Type	Count
FaceForensics++ [1]	Deepfake Detection	767
	Deepfakes	260
	Face2Face	264
	FaceShifter	263
	FaceSwap	263
	Neural Textures	258
	Original	2542
Celeb-DF [2]	Fake	1580
	Original	1741
DeepfakeTIMIT [3]	Fake	91

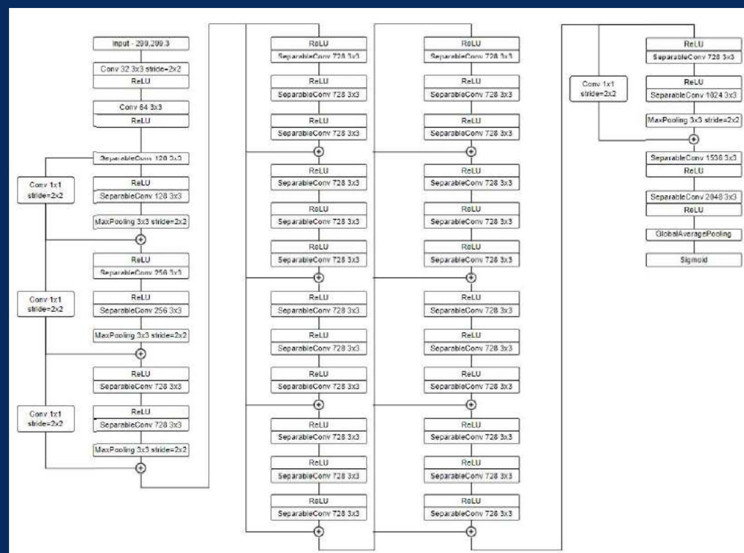
Detailed data distribution of test set

[1] A. Rössler, D. Cozzolino, L. Verdoliva, C. Riess, J. Thies and M. Nießner, "FaceForensics++: Learning to Detect Manipulated Facial Images," in ICCV, 2019.
[2] Y. Li, P. Sun, H. Qi and S. Lyu, "Celeb-DF: A Large-scale Challenging Dataset for DeepFake Forensics," in IEEE Conference on Computer Vision and Patten Recognition (CVPR), Seattle, WA, United States, 2020.
[3] P. Korshunov and S. Marcel, "DeepFakes: a New Threat to Face Recognition? Assessment and Detection," 2018.

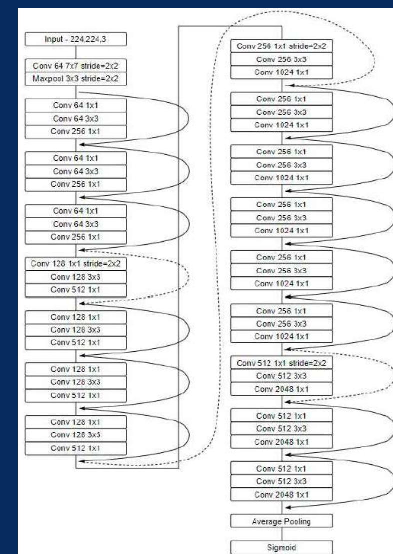
Models



VGG-19 [1]



Xception [2]

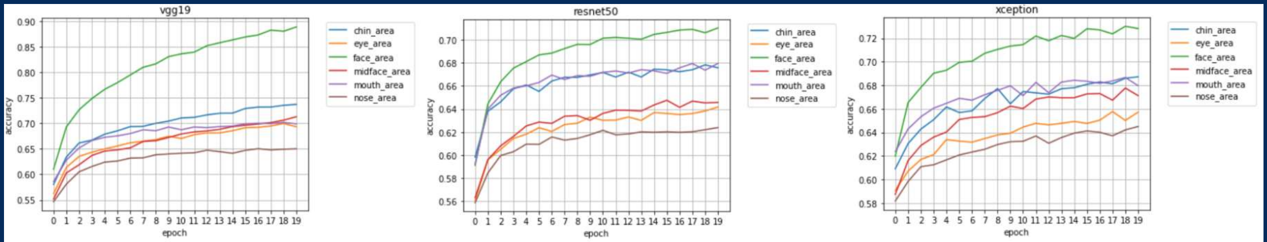


ResNet-50 [3]

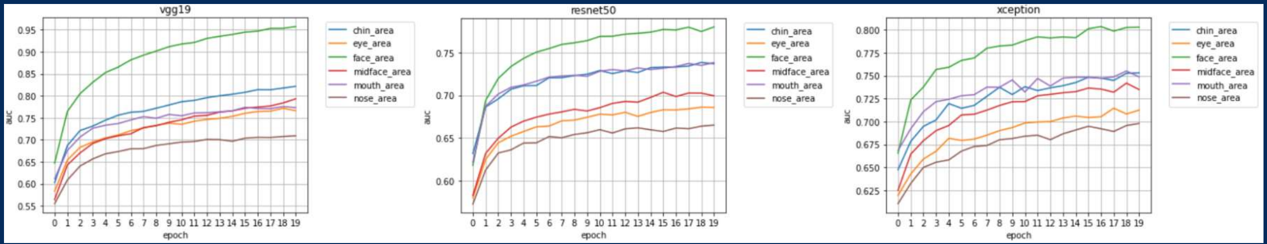
[1] K. Simonyan and A. Zisserman, "Very Deep Convolutional Networks for Large-Scale Image Recognition," 2015.
[2] F. Chollet, "Xception: Deep Learning with Depthwise Separable Convolutions," in IEEE/CVF Conference on Computer Vision and Pattern, 2017.
[3] K. He, X. Zhang, S. Ren and J. Sun, "Deep Residual Learning for Image Recognition,"in CVPR, 2016.

Results

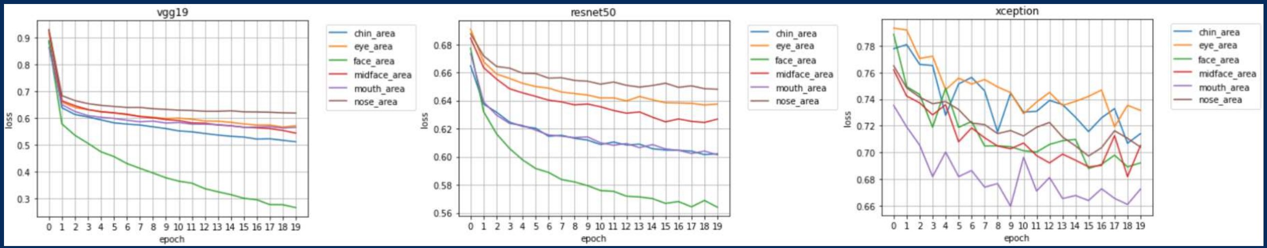
Train Results



Accuracy



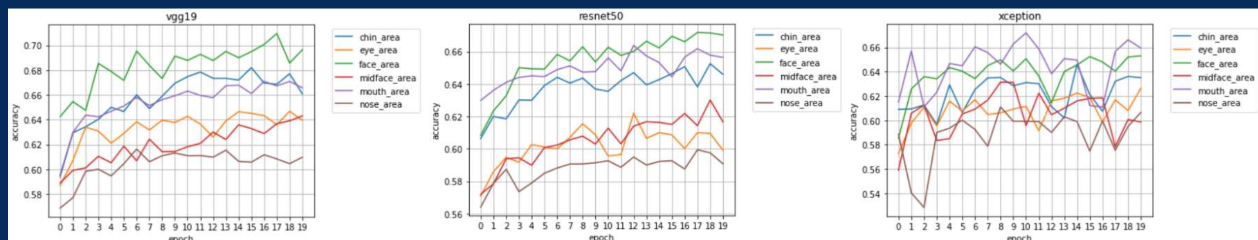
AUC



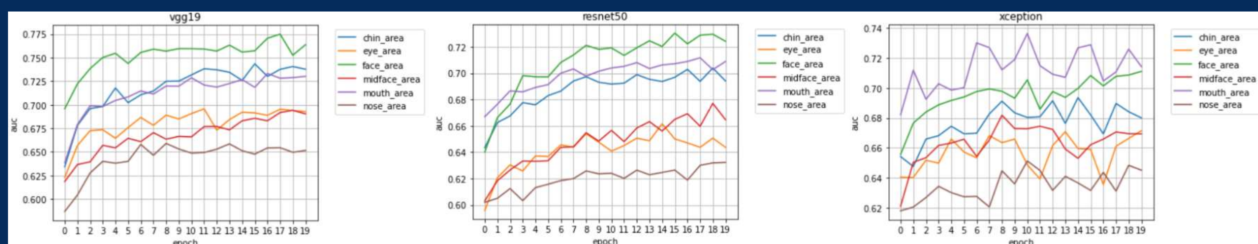
Loss

Results

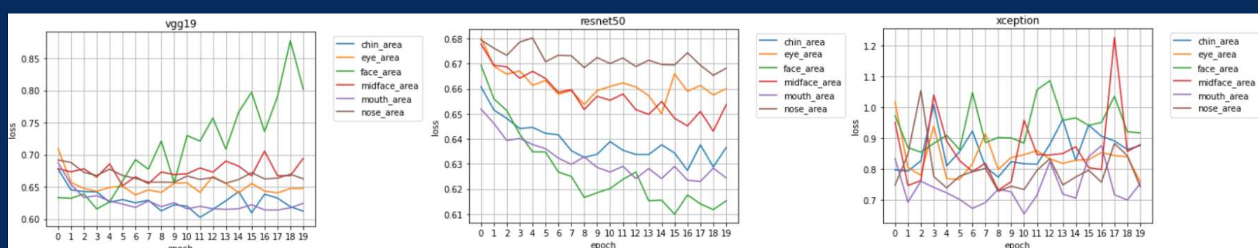
Validation Results



Accuracy



AUC



Loss

Results

Test Results

region	VGG19 [1]	ResNet50 [2]	Xception [3]
chin_area	0.66185081	0.65250963	0.645534933
eye_area	0.635446489	0.616639674	0.628347218
face_area	0.679412127	0.674305618	0.613899589
midface_area	0.620874345	0.631211877	0.642172098
mouth_area	0.676422954	0.663594484	0.666832745
nose_area	0.610536814	0.607049465	0.602192044

Accuracies of models and facial regions.

region	VGG19 [1]	ResNet50 [2]	Xception [3]
chin_area	0.720196605	0.704772115	0.697542071
eye_area	0.687221289	0.667445362	0.677461565
face_area	0.74442941	0.736271441	0.642947078
midface_area	0.664794207	0.685279429	0.691203296
mouth_area	0.731904447	0.722529709	0.728539944
nose_area	0.649096489	0.642353654	0.639755368

AUC scores of models and facial regions.

[1] K. Simonyan and A. Zisserman, "Very Deep Convolutional Networks for Large-Scale Image Recognition," 2015.
[2] K. He, X. Zhang, S. Ren and J. Sun, "Deep Residual Learning for Image Recognition,"in CVPR, 2016.
[3] F. Chollet, "Xception: Deep Learning with Depthwise Separable Convolutions," in IEEE/CVF Conference on Computer Vision and Pattern, 2017.

Results

Test Results Contd.

Dataset	Category	chin_area			eye_area			face_area			midface_area			mouth_area			nose_area		
		Resnet50	VGG19	Xception	Resnet50	VGG19	Xception	Resnet50	VGG19	Xception	Resnet50	VGG19	Xception	Resnet50	VGG19	Xception	Resnet50	VGG19	Xception
Celeb-DF [1]	Real	0.51	0.53	0.73	0.46	0.53	0.57	0.62	0.70	0.68	0.73	0.66	0.36	0.59	0.51	0.68	0.66	0.52	0.56
	Fake	0.79	0.79	0.53	0.79	0.81	0.69	0.75	0.79	0.68	0.56	0.64	0.85	0.77	0.83	0.64	0.54	0.74	0.70
	Youtube	0.65	0.70	0.82	0.54	0.58	0.66	0.75	0.85	0.76	0.75	0.73	0.42	0.66	0.60	0.72	0.73	0.63	0.60
DeepfakeTIMIT [2]	Fake	0.78	0.80	0.65	0.65	0.84	0.70	0.75	0.73	0.69	0.42	0.74	0.91	0.56	0.75	0.59	0.57	0.80	0.89
Faceforensics++ [3]	DeepfakeDetection	0.61	0.76	0.67	0.56	0.76	0.61	0.69	0.58	0.68	0.41	0.56	0.84	0.69	0.75	0.64	0.36	0.53	0.58
	Face2Face	0.53	0.45	0.55	0.41	0.36	0.38	0.47	0.38	0.49	0.45	0.38	0.79	0.43	0.56	0.44	0.27	0.35	0.61
	FaceShifter	0.28	0.38	0.43	0.49	0.43	0.44	0.33	0.23	0.34	0.30	0.28	0.65	0.27	0.33	0.27	0.29	0.44	0.51
	FaceSwap	0.20	0.27	0.30	0.22	0.41	0.34	0.18	0.33	0.32	0.25	0.26	0.65	0.12	0.24	0.20	0.16	0.23	0.41
	NeuralTextures	0.62	0.52	0.58	0.39	0.35	0.31	0.37	0.22	0.42	0.51	0.32	0.73	0.52	0.60	0.47	0.31	0.38	0.51
	Original	0.74	0.70	0.68	0.76	0.69	0.71	0.80	0.81	0.73	0.83	0.78	0.47	0.80	0.74	0.81	0.83	0.70	0.63
	Deepfakes	0.60	0.68	0.65	0.57	0.50	0.58	0.57	0.48	0.61	0.39	0.47	0.78	0.67	0.71	0.65	0.39	0.53	0.60

Accuracies of each sub dataset for each region and model (VGG19 [4], Resnet50 [5], Xception [6])

[1] Y. Li, P. Sun, H. Qi and S. Lyu, "Celeb-DF: A Large-scale Challenging Dataset for DeepFake Forensics," in IEEE Conference on Computer Vision and Patten Recognition (CVPR), Seattle, WA, United States, 2020.
[2] P. Korshunov and S. Marcel, "DeepFakes: a New Threat to Face Recognition? Assessment and Detection," 2018.
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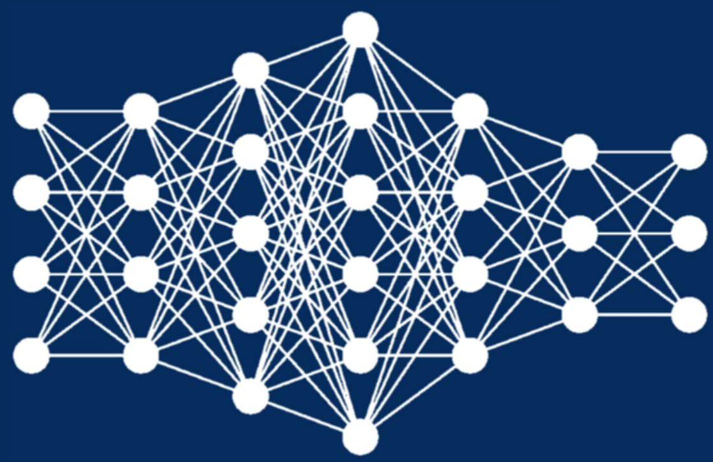
[4] K. Simonyan and A. Zisserman, "Very Deep Convolutional Networks for Large-Scale Image Recognition," 2015.
[5] K. He, X. Zhang, S. Ren and J. Sun, "Deep Residual Learning for Image Recognition,"in CVPR, 2016.
[6] F. Chollet, "Xception: Deep Learning with Depthwise Separable Convolutions," in IEEE/CVF Conference on Computer Vision and Pattern, 2017.

Future Work

- More balanced distributed dataset
- Complex ANNs
- RNN based deepfake detector
- Different face detectors



THANK YOU FOR LISTENING!

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