Alzheimer's Dementia Classification from Magnetic Resonance Imaging (MRI)

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Outline

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Dataset

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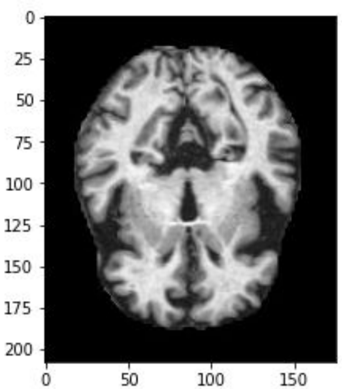
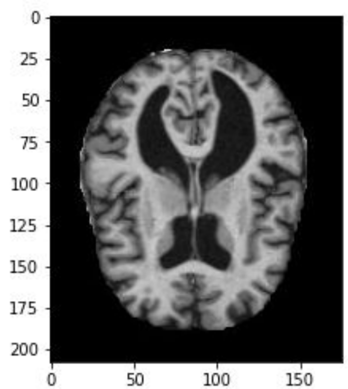
The data consists of magnetic resonance images of Alzheimer's patients in differents stages of dementia. It has four classes of images both in training as well as a testing set. Each image has 208x176 size.[1]

Non demented



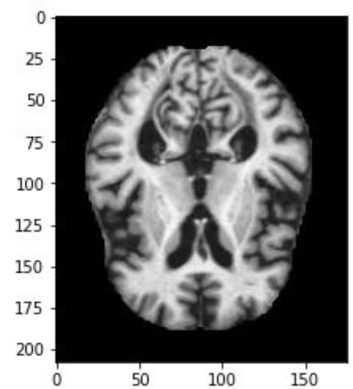
Train: 2560
Test: 640

Very Mild Demented



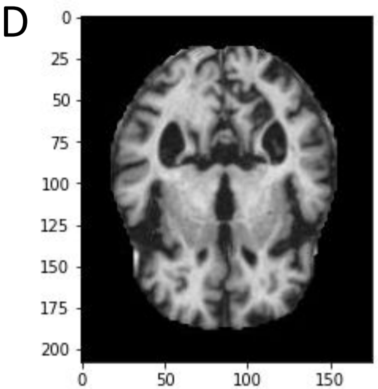
Train: 1792
Test: 448

Mild Demented



Train: 717
Test: 179

Moderate D



Train: 52
Test: 12

1. https://www.kaggle.com/tourist55/alzheimers-dataset-4-class-of-images

Convolutional Neural Networks

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Model 1	
Layer Type	**Output shape**
Conv (4)	205x173x32
Max Pool (2)	102x86x32
Conv (4)	99x83x64
Max Pool (2)	49x41x64
Dense	128, 64

Model 2	
Layer Type	**Output shape**
Conv (4)	205x173x32
Max Pool (2)	102x86x32
Conv (4)	99x83x64
Max Pool (2)	49x41x64
Conv (5)	45x37x128
Max Pool (2)	22x18x128
Dense	128, 64

Model 3	
Layer Type	**Output shape**
Conv (4)	205x173x32
Max Pool (2)	102x86x32
Conv (4)	99x83x64
Max Pool (2)	49x41x64
Conv (5)	45x37x128
Max Pool (2)	22x18x128
Dense	128, 64, 32

Model 4					
Layer Type	**Output shape**	**Layer Type**	**Output shape**	**Layer Type**	**Output shape**
Conv (2)	207x176x16	Max Pool (2)	50x42x32	Conv (4)	19x15x128
Max Pool (2)	103x87x16	Conv (4)	47x39x64	Max Pool (2)	9x7x128
Conv (4)	100x84x32	Max Pool (2)	23x19x64	Dense	128, 64, 32

Convolutional Neural Networks

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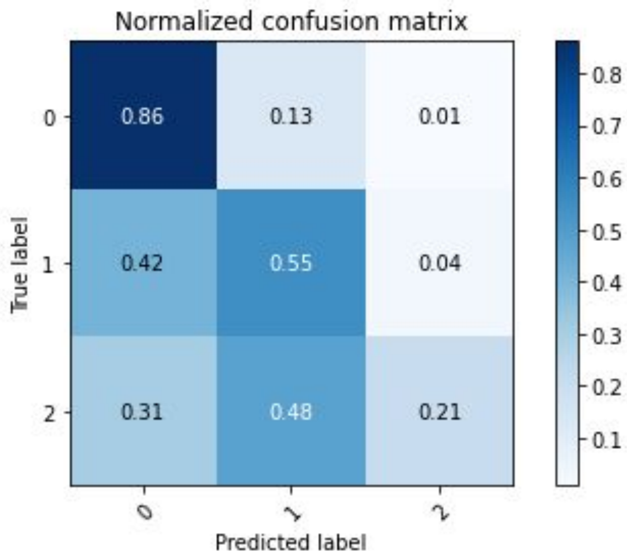
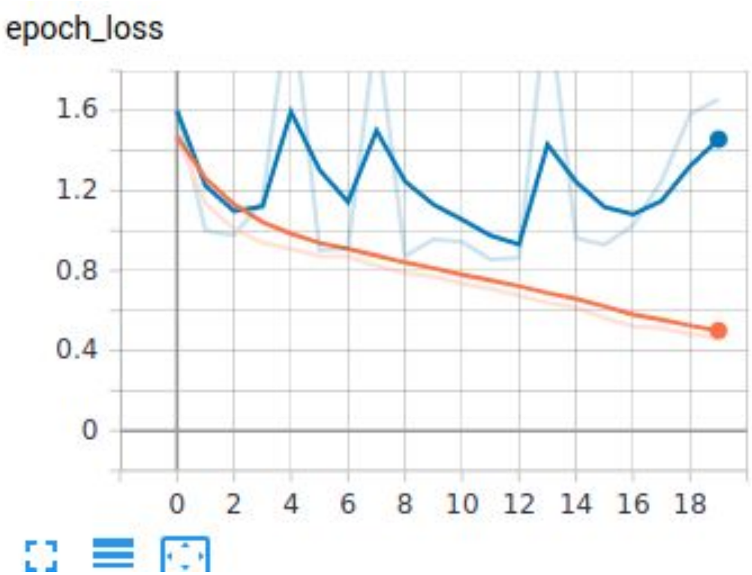
Results		
	Accuracy	**Balanced Acc.**
Model 1	57.22	44.80
Model 2	64.96	50.79
Model 3	60.30	45.37
Model 4	65.90	54.08





TensorFlow Hub

It is used a model from TensorFlow Hub [2]. The selected model provides feature vector of dimension 1280 from input images of size 96x96x3. This model was trained with ImageNet (ILSVRC-2012-CLS).

Using classic SVM

Parameters	
Kernel	Rbf
C	1.0
Gamma	0.001

Using model in TF

Model	
Layer Type	**Output shape**
Keras	1280
Dense	512
Dense	256
Dense	128
Dense	64

2. https://tfhub.dev/google/imagenet/mobilenet_v2_075_96/feature_vector/4

TensorFlow Hub

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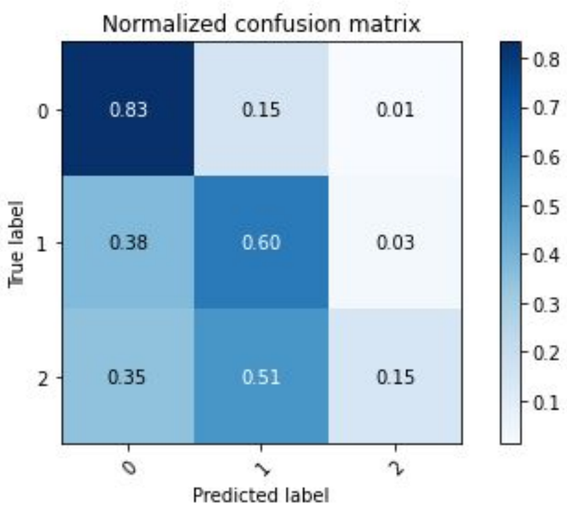
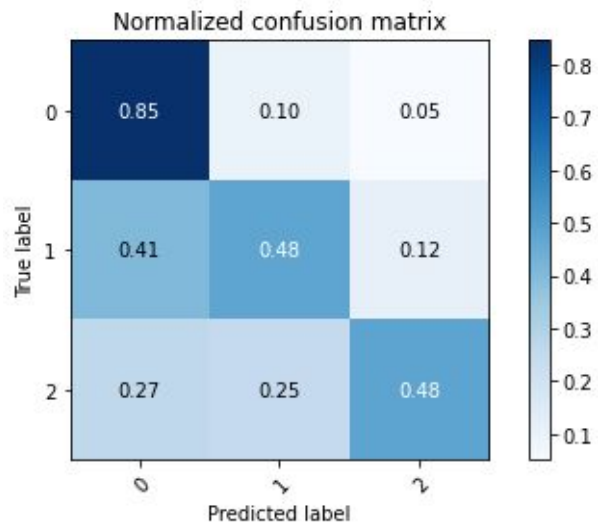
Results		
	Accuracy	**Balanced Acc.**
Classic SVM	65.19%	52.47%
Model without re-training	66.38%	60.11%
Model with re-training	59.75%	65.15%

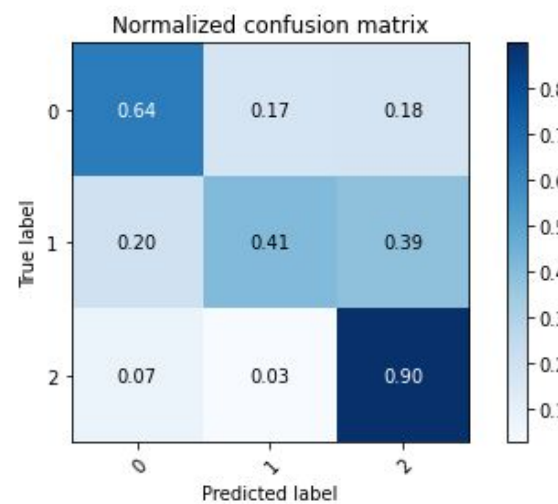
Classic SVM



Without re-training



With re-training



Transfer learning

The base model was Alexnet's first two layers. In addition, we performed transfer learning with and without layer freezing.

- Experiment 1: Train from scratch.
- Experiment 2: Transfer learning without layer freezing.
- Experiment 3: Transfer learning with layer freezing (1st layer).
- Experiment 4: Transfer learning with layer freezing (1st layer + 2nd layer).

Architecture	
Layer Type	**Output shape**
Conv (11)	22x22x96
Max Pool (2)	11x11x96
Conv (5)	7x7x256
Max Pool (2)	3x3x256
Dense	128
Dense	64

Transfer learning

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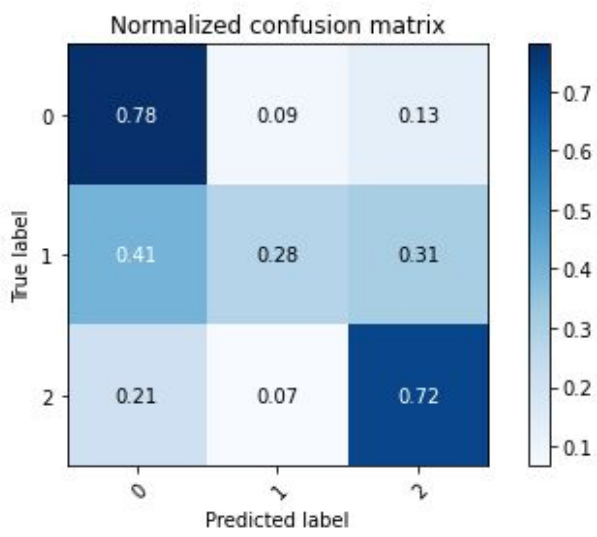
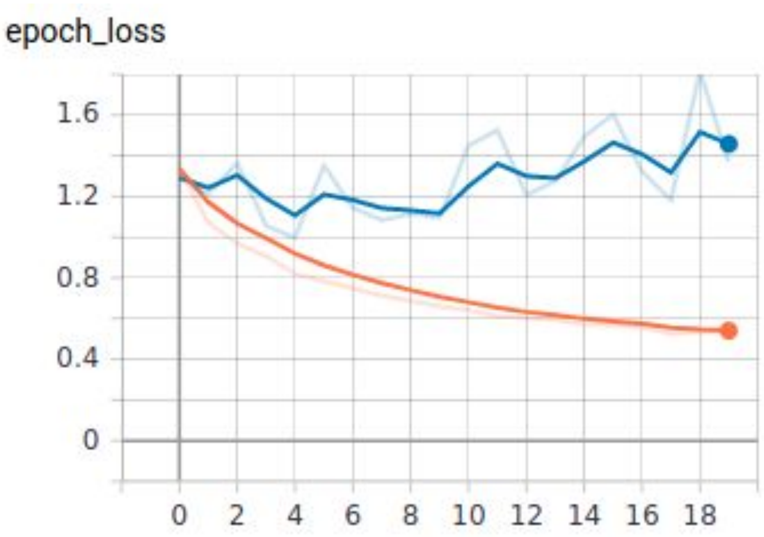
Results		
	Accuracy	**Balanced Acc.**
Experiment 1	37.02	34.85
Experiment 2	61.25	57.15
Experiment 3	59.59	59.46
Experiment 4	57.30	43.44





Summary

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Results CNNs		
	Accuracy	**Balanced Acc.**
Model 1	57.22	44.80
Model 2	64.96	50.79
Model 3	60.30	45.37
Model 4	65.90	54.08

Results Transfer Learning		
	Accuracy	**Balanced Acc.**
Exp. 1	37.02	34.85
Exp. 2	61.25	57.15
Exp. 3	59.59	59.46
Exp. 4	57.30	43.44

Results TensorFlow Hub		
	Accuracy	**Balanced Acc.**
Classic SVM	65.19%	52.47%
Model without re-training	66.38%	60.11%
Model with re-training	59.75%	65.15%

Conclusions

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- The proposed methods using CNNs are useful to classify the different stages of severity of dementia in Alzheimer's disease based on MRI images, which would be very useful for support in the diagnosis and therapy of the disease.

- Different techniques such as dropout and L2 regularization are very useful when the models are implemented with real data, because these techniques allow a better generalization of the phenomenon and helps to avoid the overfitting of the network.

- Transfer learning uses feature maps of robust models and allows for adjustment in training. This is very useful for classifying small databases that do not have enough data to train deep learning models.

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