

Neural Networks

Glynis Mattheisen



How can we better diagnose Alzheimer's disease in patients?

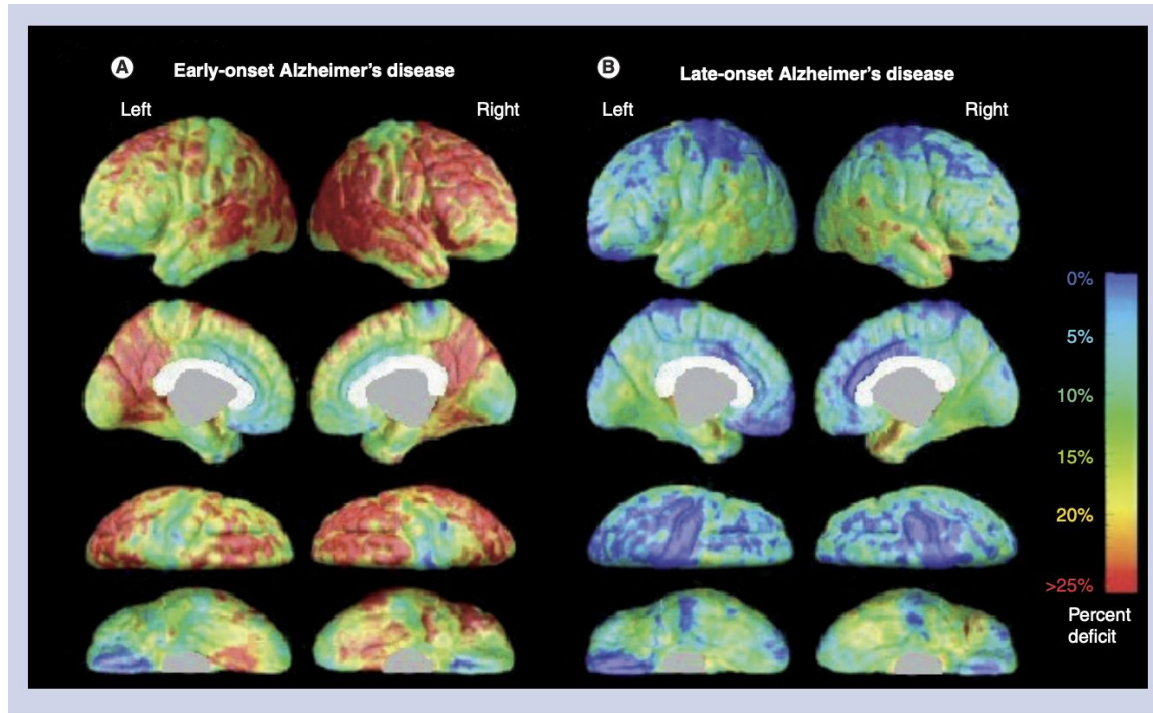
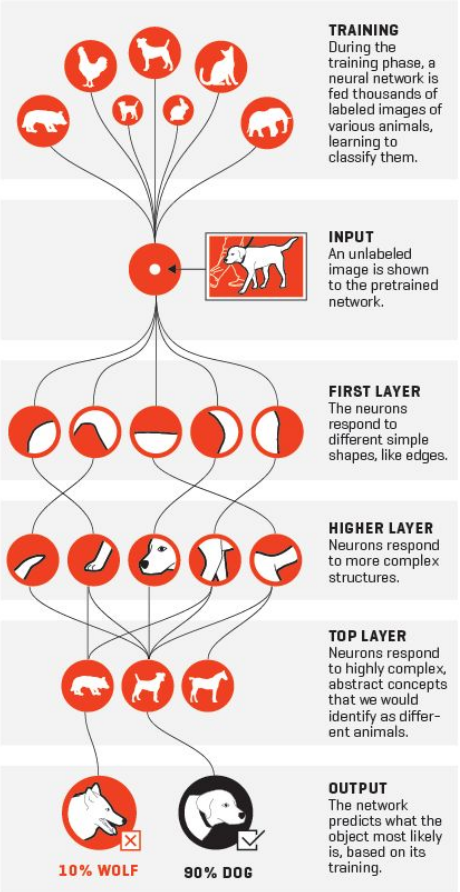
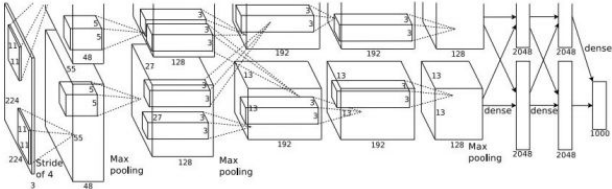


Figure 8. Gray matter loss in (A) a group of early-onset Alzheimer's disease and (B) a group of late-onset Alzheimer's disease patients compared with a group of normal controls assessed by cortical pattern matching.

HOW NEURAL NETWORKS RECOGNIZE A DOG IN A PHOTO



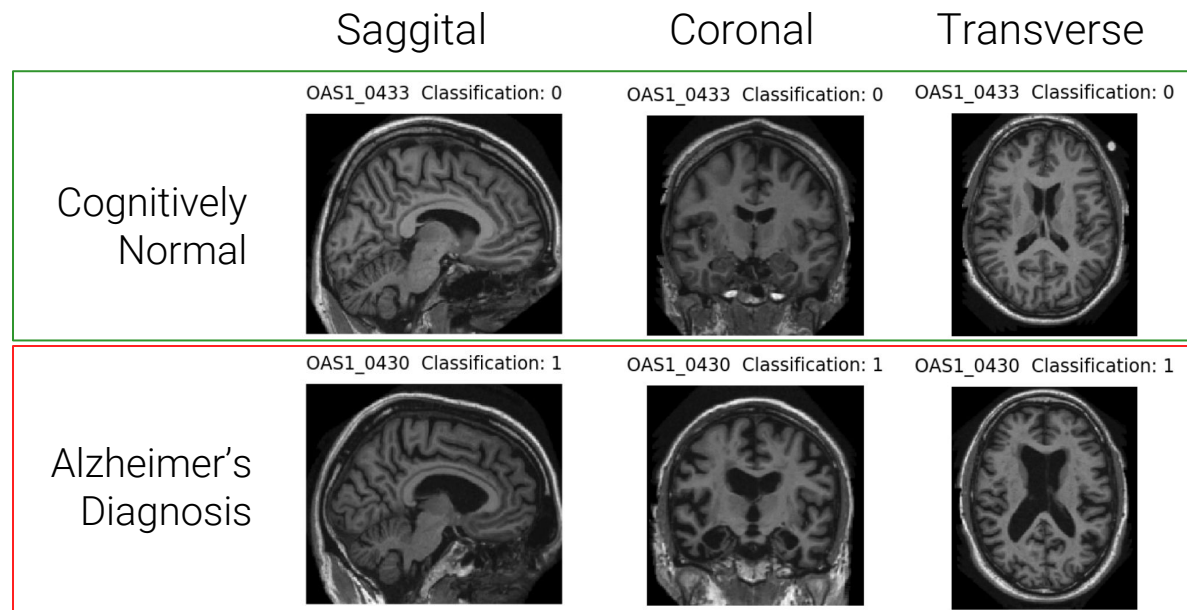
How do neural networks achieve image recognition?

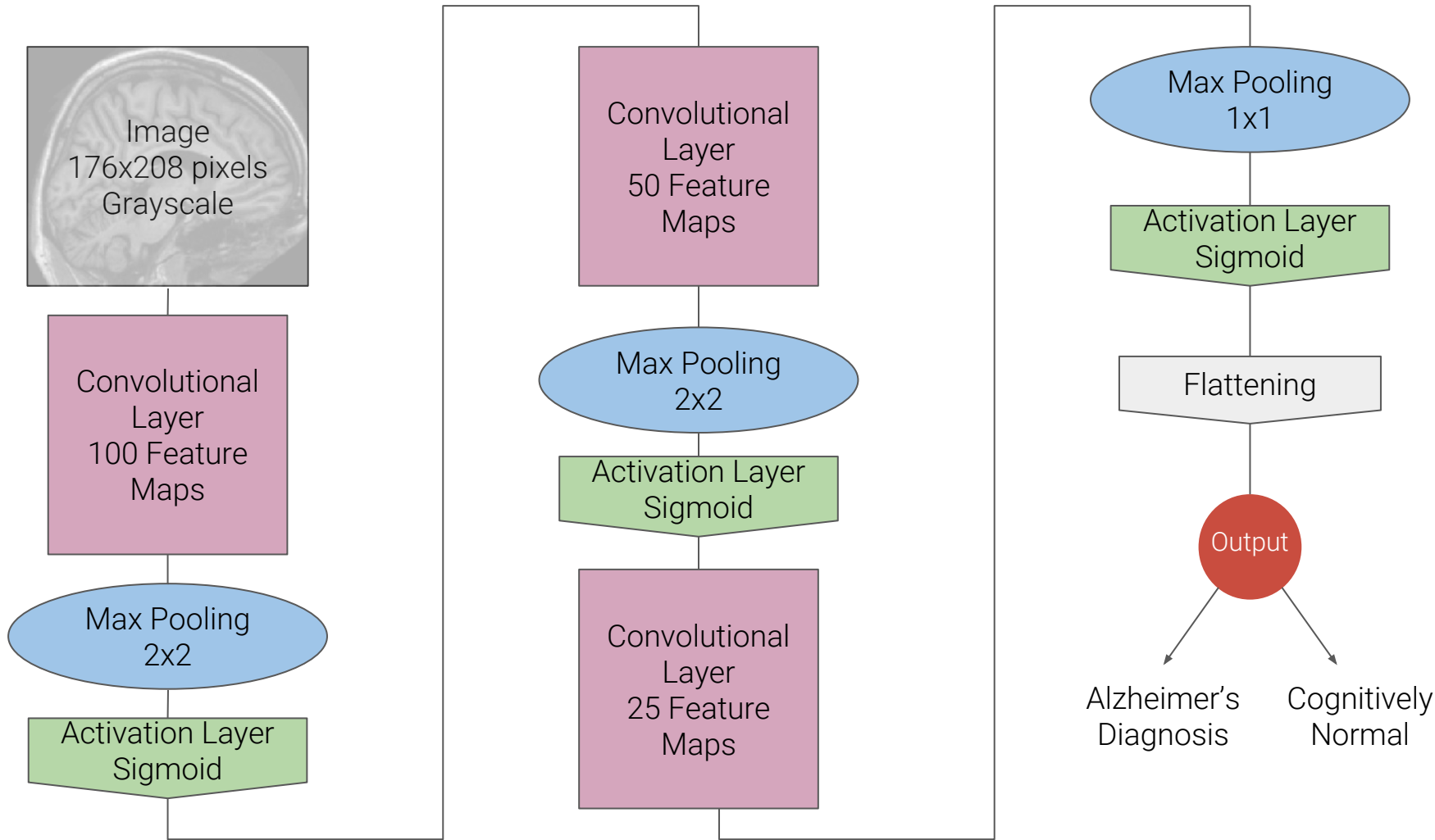


Dog

430 patients

- 330 Cognitively normal
- 100 Alzheimer's diagnosis





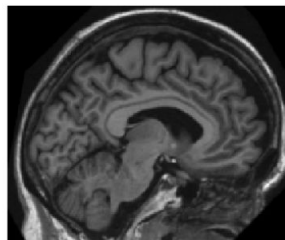
Saggital

Coronal

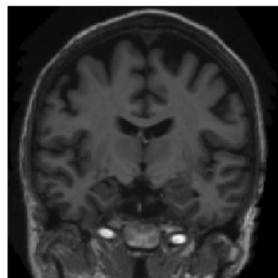
Transverse

	Accuracy	Precision	Recall
Data Processing			
TRA_Model	88.02	85.56	91.67
SAG_Model	86.83	85.23	89.29
CORR_Model	80.84	86.11	73.81

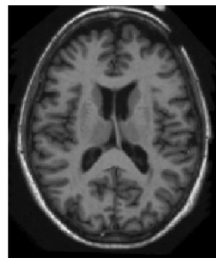
OAS1_0426 Classification: 0



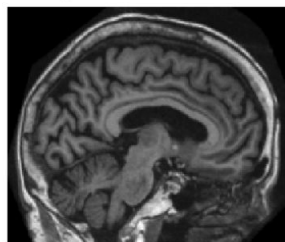
OAS1_0426 Classification: 0



OAS1_0426 Classification: 0



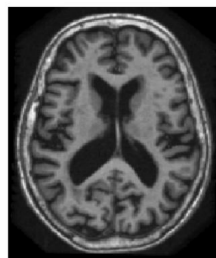
OAS1_0425 Classification: 1



OAS1_0425 Classification: 1



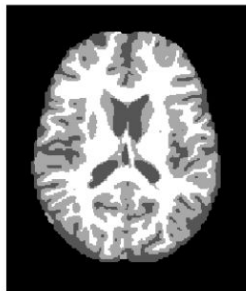
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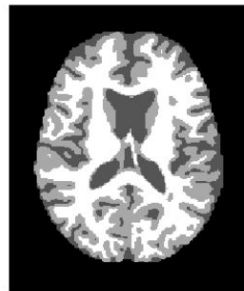
Raw



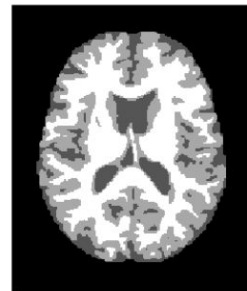
OAS1_0433 Classification: 0



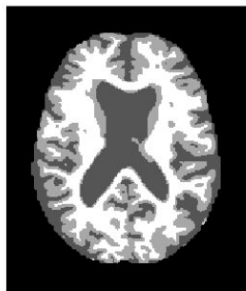
OAS1_0432 Classification: 1



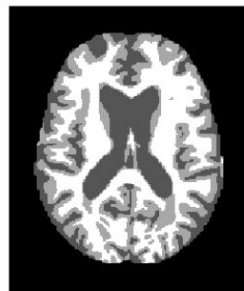
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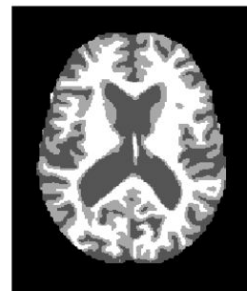
OAS1_0430 Classification: 1



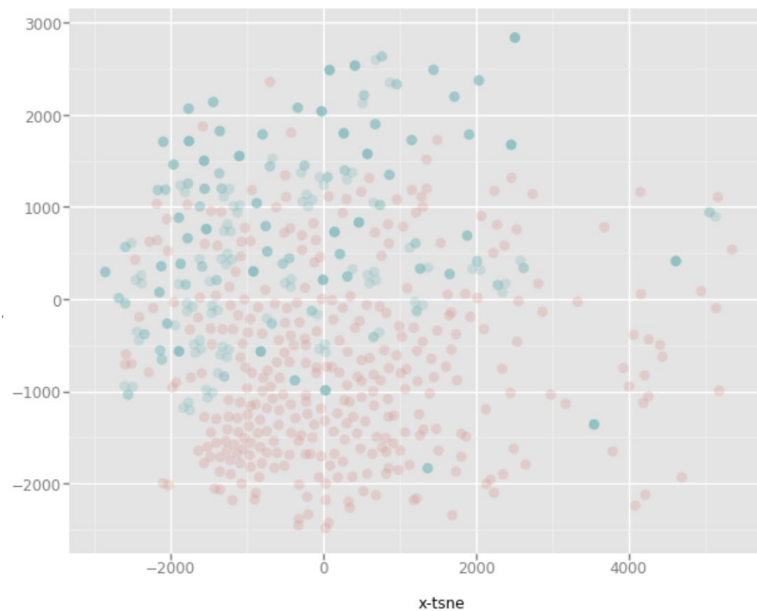
OAS1_0424 Classification: 1



OAS1_0425 Classification: 1



t-SNE with Raw MRI Images



Alzheimer's

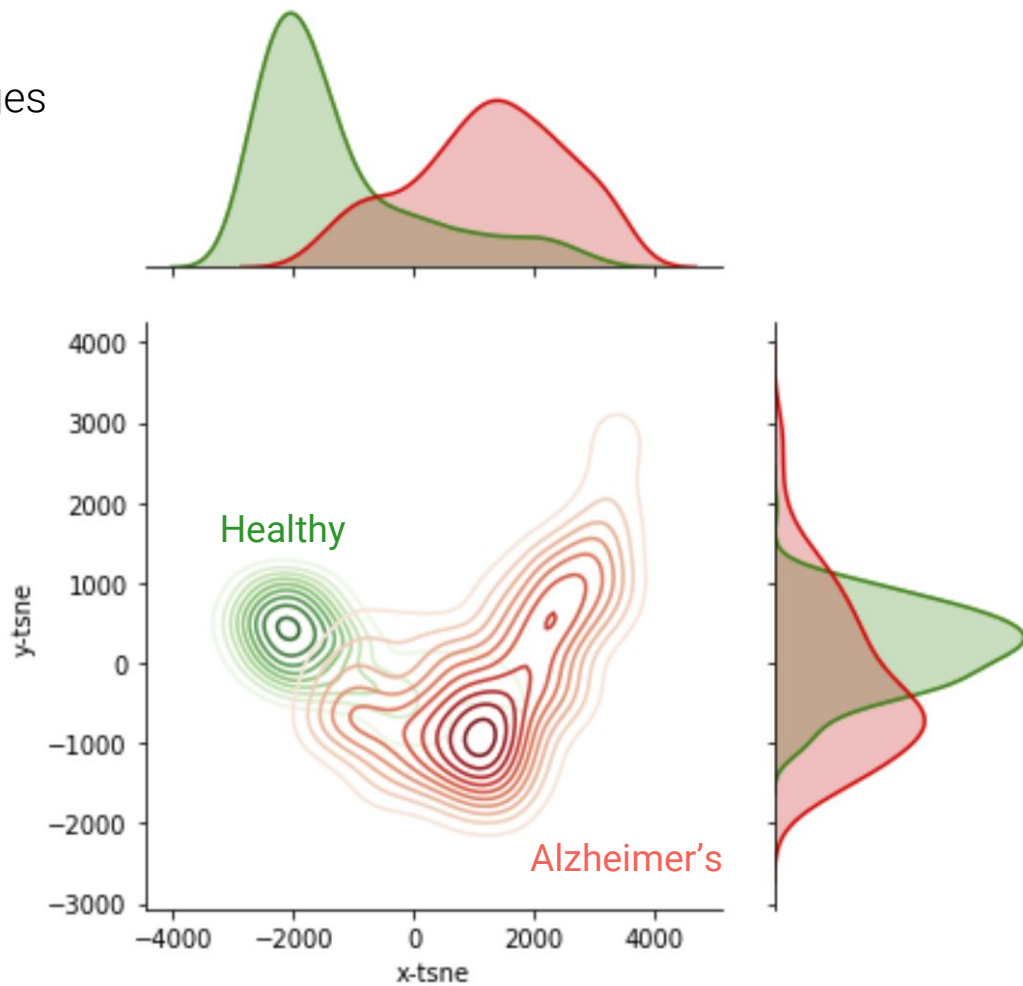
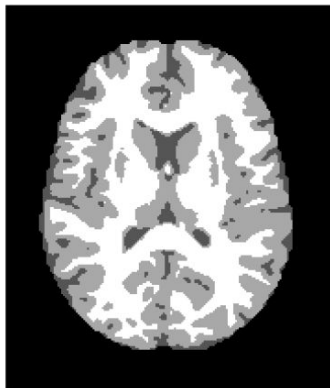
Normal

	Accuracy	Precision	Recall
Data Processing			
TRA_t	74.85	76.92	71.43
SAG_T	68.86	71.62	63.10
CORR_t	67.07	64.95	75.00

OAS1_0426 Classification: 0



t-SNE with Masked-MRI Images



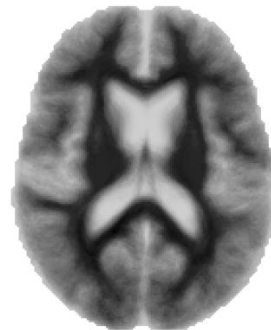
Raw



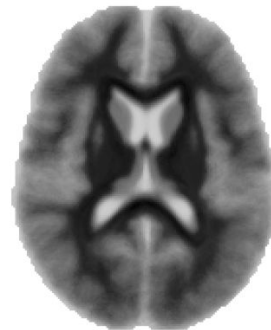
OAS1_0448 Classification: 0



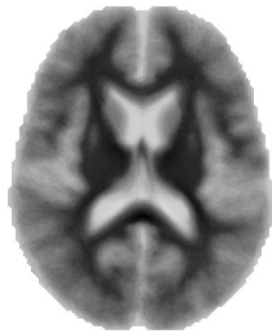
OAS1_0449 Classification: 1



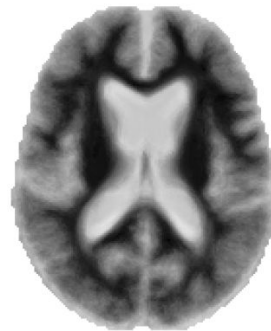
OAS1_0439 Classification: 1



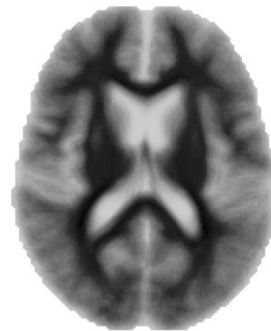
OAS1_0438 Classification: 1



OAS1_0428 Classification: 1

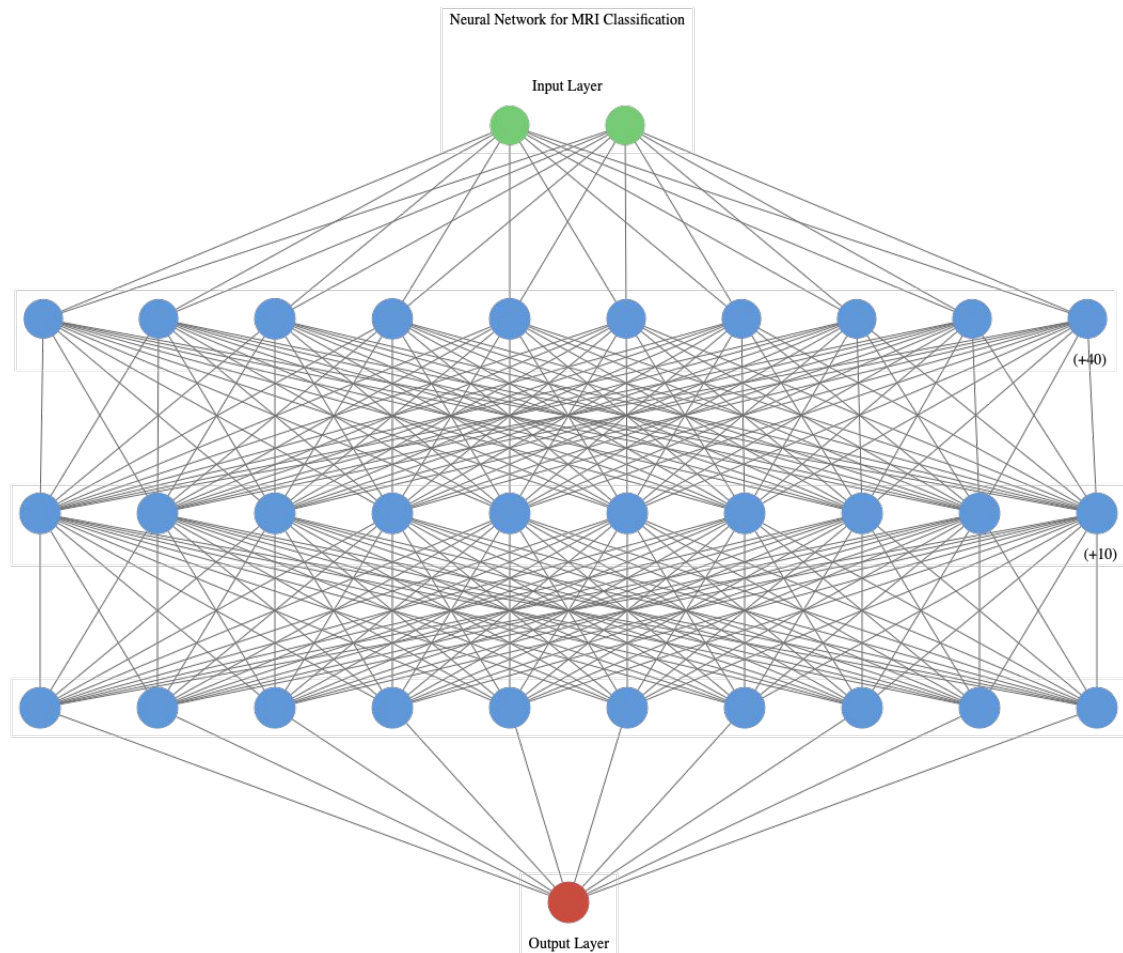
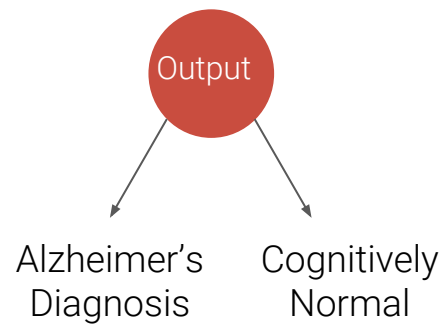


OAS1_0429 Classification: 0

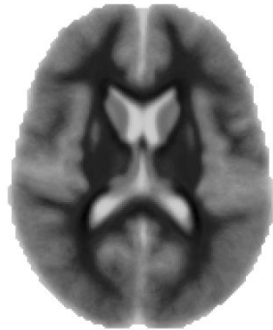


3 layers

- 50 neurons
- 30 neurons
- 15 neurons



PCA + ANN Provides the Best Predictions on MRI Data

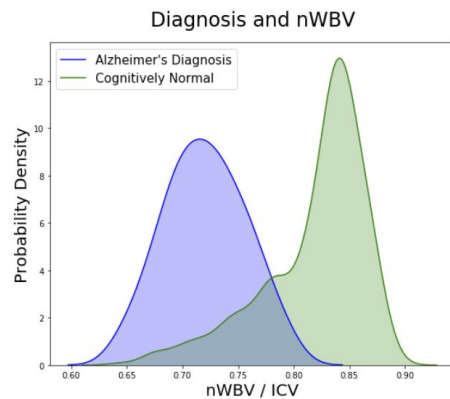
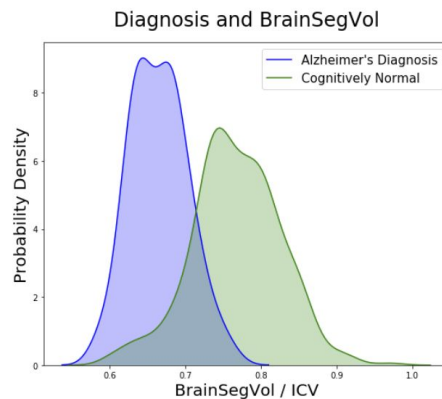
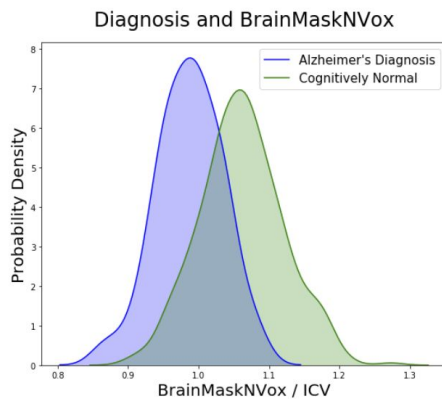
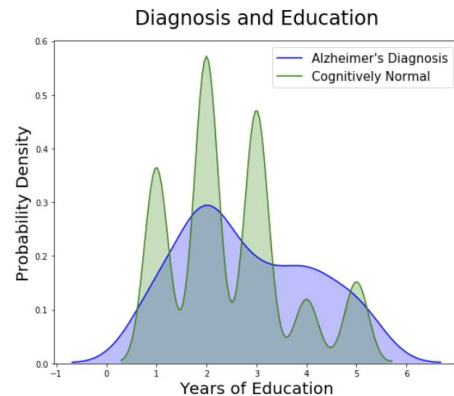
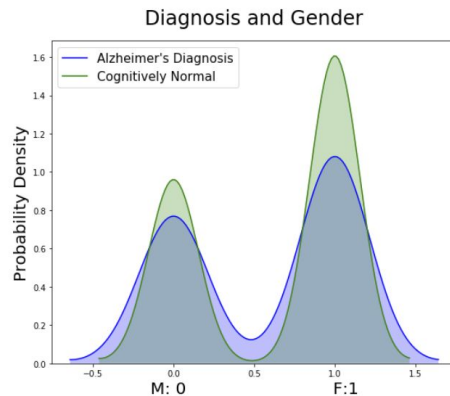
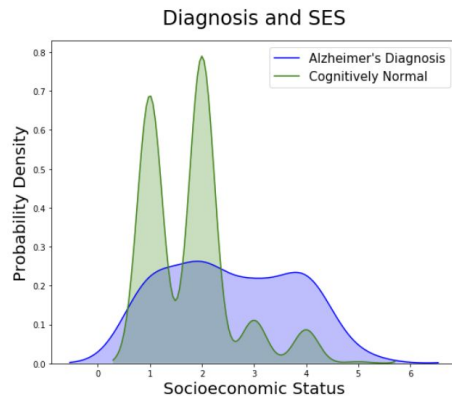
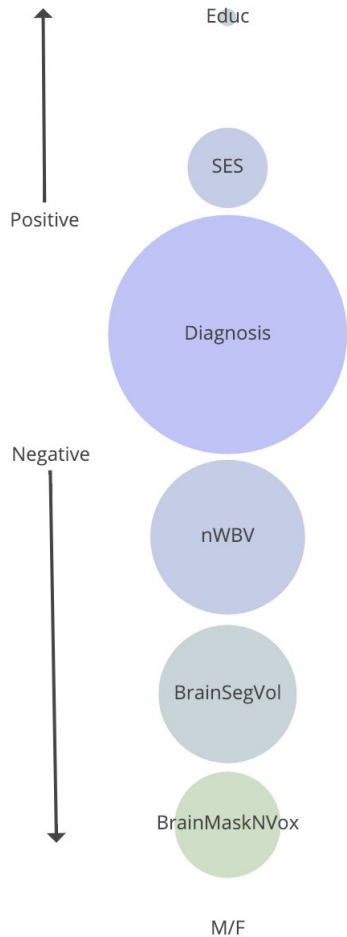


		Accuracy	Precision	Recall
Model				
	PCA + NN	94.61	92.13	97.62
	T-SNE + NN	88.02	87.21	89.29
	NN	86.83	82.29	94.05

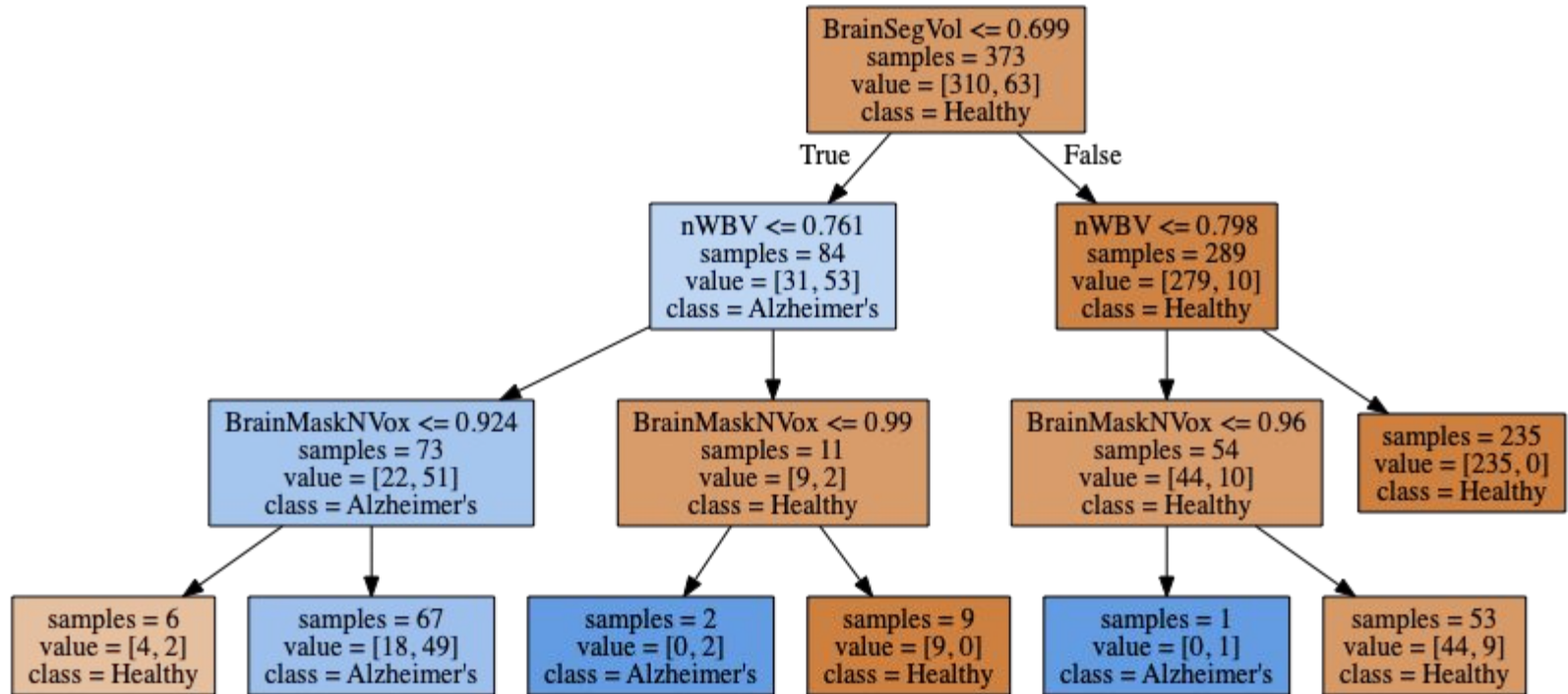
Demographic Data and Derived Anatomical Measures

- **M/F** - Male: 0, Female: 1
- **EDUC** - Years of education
- **SES** - Socioeconomic status as assessed by the Hollingshead Index of Social Position and classified into categories from 1 (*highest status*) to 5 (*lowest status*)
- **nWBV** - normalized whole brain volume
- **BrainMaskNVox** - total volume of non-zero voxels, includes cerebellum and ventricles
- **BrainSegVol** - sum of the volume of the structures identified in the aseg.mgz volume, includes ventricles but not dura or cerebellum

	BrainMaskNVox	BrainSegVol	M/F	Educ	SES	nWBV	Diagnosis
Subject							
OAS1_0002	1.069785	0.762842	1	4	1	0.810	0
OAS1_0003	0.994005	0.677106	1	4	3	0.708	1
OAS1_0004	1.008911	0.729594	0	2	2	0.803	0
OAS1_0005	1.036834	0.789169	0	1	1	0.848	0
OAS1_0007	1.027285	0.754648	0	1	2	0.830	0
OAS1_0009	1.197409	0.891958	1	2	1	0.843	0
OAS1_0010	0.935540	0.598557	0	5	2	0.689	0
OAS1_0011	1.070432	0.754834	1	3	2	0.827	0



Random Forest

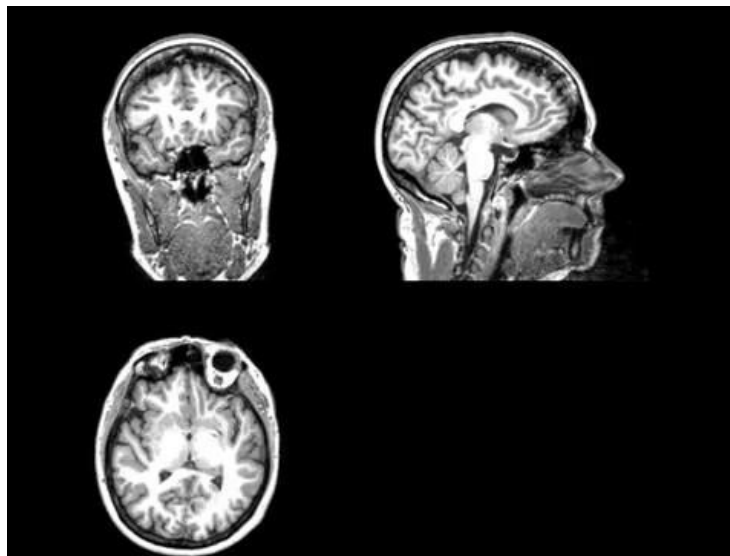


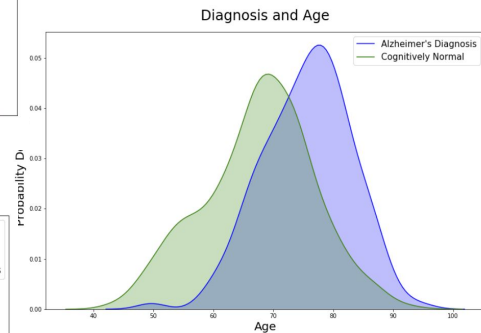
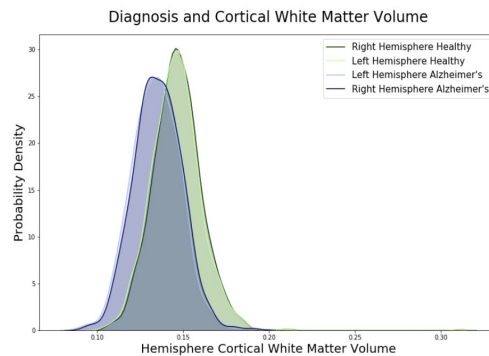
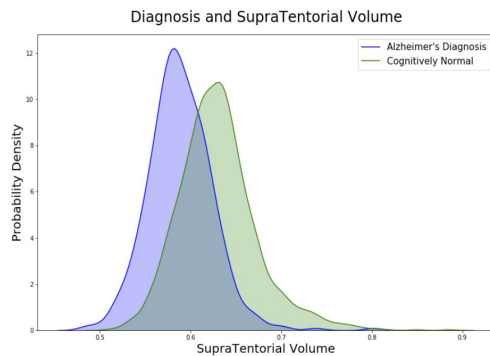
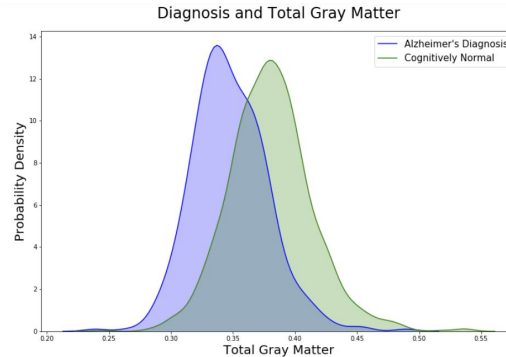
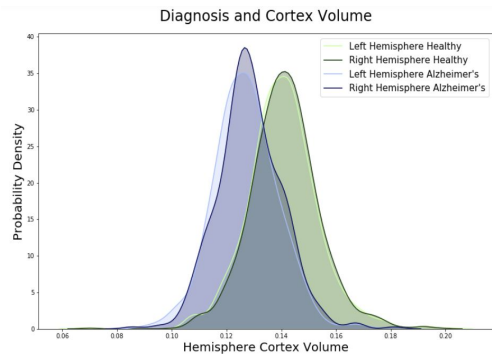
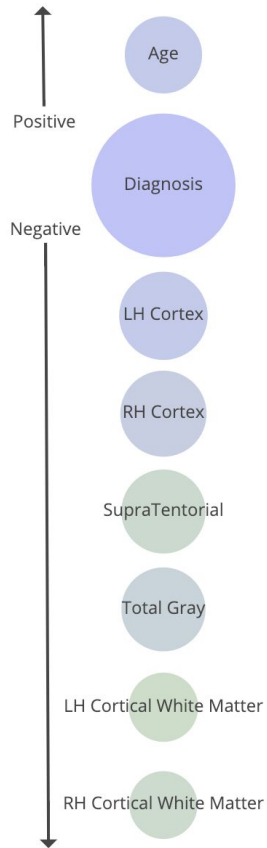
Conclusions

		Accuracy	Precision	Recall
Model				
	PCA + NN	94.61	92.13	97.62
	T-SNE + NN	88.02	87.21	89.29
	NN	86.83	82.29	94.05
	Demographic Data + RF	84.8	62.96	65.38

1098 patients

- 609 Cognitively normal
- 409 in various stages of cognitive decline

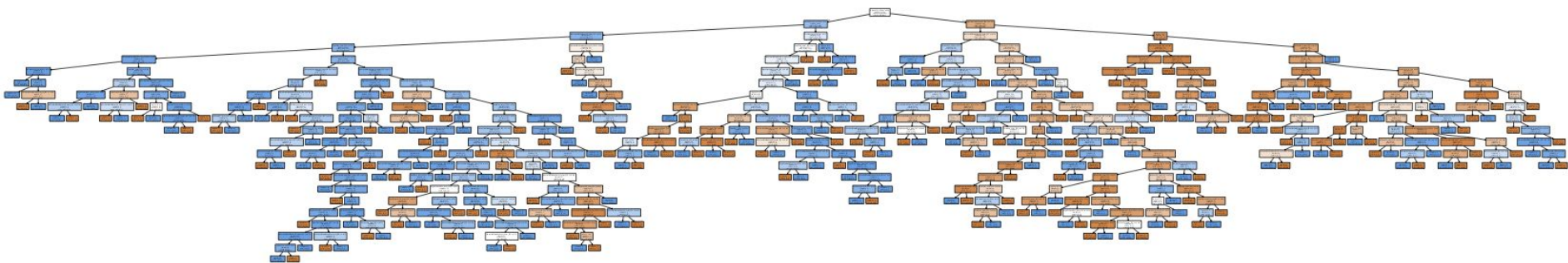




Can MRI Values Predict Alzheimer's Before a Physician Can?

	ADRC_ADRCLINICALDATA ID	Subject	mmse	cdr	dx1	dx2	dx3	dx4	dx5
112	OAS30022_ClinicalData_d0000	OAS30022	30	0	Cognitively normal	.	.	.	.
113	OAS30022_ClinicalData_d0519	OAS30022	26	0	Cognitively normal	.	.	.	.
114	OAS30022_ClinicalData_d1149	OAS30022	27	0	Cognitively normal	.	.	.	.
115	OAS30022_ClinicalData_d1906	OAS30022	20	1	AD Dementia	.	.	.	.
116	OAS30022_ClinicalData_d2292	OAS30022	18	1	AD Dementia	.	.	.	.
117	OAS30022_ClinicalData_d2843	OAS30022	20	1	AD Dementia	AD dem w/oth (list B) contribut	Active Alcoholism	.	.
118	OAS30022_ClinicalData_d3382	OAS30022	18	1	AD dem disturbed social- with	.	.	.	.
119	OAS30022_ClinicalData_d3822	OAS30022	18	2	AD Dementia	.	.	.	.

Random Forest



Accuracy

Precision

Recall

Model

89.97

85.61

96.1

ML Models can Accurately Predict Alzheimer's Disease in Patients before a Clinical Diagnosis

	Accuracy	Precision	Recall
Model	89.97	85.61	96.1
Pre-Diagnosis Prediction	97.93	-	-

ADRC_ADRCLINICALDATA ID	Subject	mmse	ageAtEntry	cdr	dx1
112 OAS30022_ClinicalData_d0000	OAS30022	30	74.3244	0	Cognitively normal

	Subject	lhCortexVol_norm_ICV	rhCortexVol_norm_ICV	CortexVol_n_ICV
OAS30022_Freesurfer50_d1324	OAS30022	0.121309	0.121239	0.242549

Alzheimer's Diagnosis