Our Learning the Latent Heat Diffusion Process through Structural Brain Network from Longitudinal Amyloid-\beta Data

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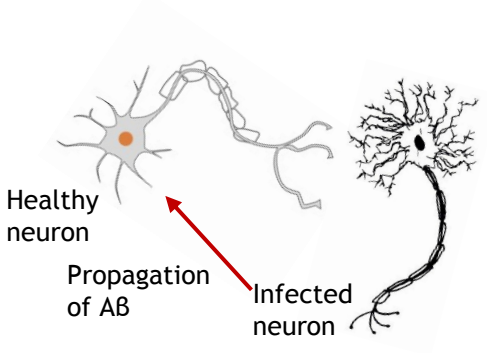
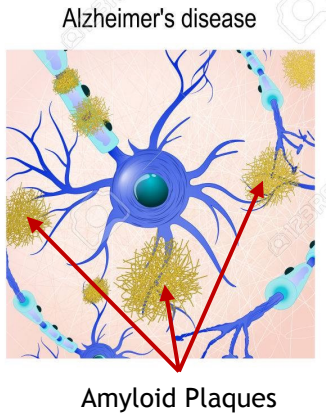
Amyloid (Aβ) Propagation in Alzheimer's brain

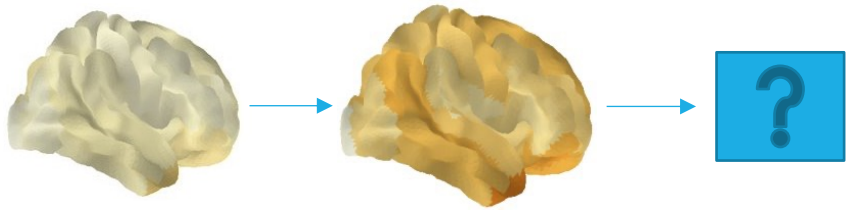
- Amyloid (AB) peptide --- hallmark of Alzheimer's
- Large Scale Brain Network as a medium to propagate these AB plaques





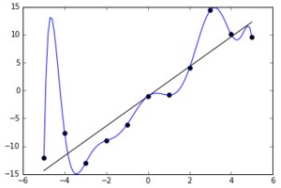
Problem Statement

- Given Amyloid burden of current time point, predict future amyloid burden



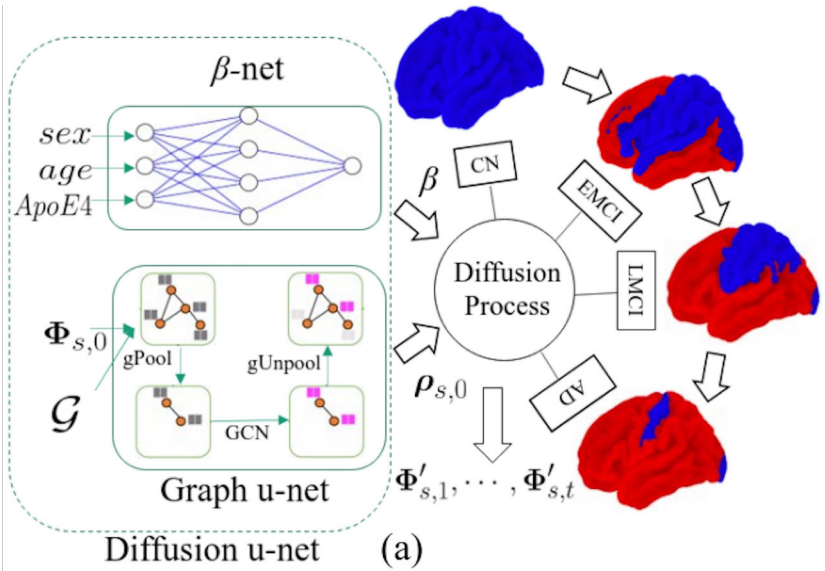
Challenges

- Few time points per subject
- Noisy and Heterogenous data distribution
- Neural networks seem to overfit


Overfitting

Our Method

- Constrains Search Space of Neural Network to avoid overfitting.
- Considers disease process from a heat diffusion equation.
- Learns a robust disease process which is nonlinear but also capable of learning from limited and noisy data.



Results

Table 1: r^2 values across different diagnosis groups

Model	Sex	CN	SMC	EMCI	LMCI	AD	Overall
Stationary	Female	0.74	0.61	0.73	0.60	0.51	0.79
	Male	0.83	0.55	0.79	0.77	0.82	
Linear-shared	Female	0.76	0.64	0.72	0.61	0.52	0.81
	Male	0.84	0.62	0.80	0.78	0.82	
Linear-subject	Female	0.82	0.71	0.85	0.72	0.52	0.86
	Male	0.86	0.70	0.84	0.82	0.86	
GRU	Female	0.79	0.65	0.83	0.60	0.21	0.84
	Male	0.86	0.54	0.84	0.73	0.85	
Diffusion u-net	Female	0.84	0.73	0.88	0.74	0.52	0.88
	Male	0.88	0.78	0.88	0.82	0.88	
Cluster u-net	Female	0.84	0.74	0.88	0.75	0.53	0.88
	Male	0.87	0.79	0.87	0.81	0.89	
Adaptive u-net	Female	0.87	0.77	0.91	0.78	0.56	**0.90**
	Male	0.92	0.89	0.93	0.86	0.96	

Table 2: Micro ROC values for CN/AD classification

Model	Model Description	Input	ROC
v_1	Random Forest Classifier	$\mathbf{\Phi}_{s,0}$	0.8855
		$\mathbf{\Phi}'_{s,0}$	0.8857
v_2	GCNClassifier	$\mathbf{\Phi}_{s,0}$	0.8853
		$\mathbf{\Phi}'_{s,0}$	0.8872
v_3	GRU + GCNClassifier	$\mathbf{\Phi}_s$	**0.9304**
		$\mathbf{\Phi}'_s$	0.9288
v_4	Min-Max + GCNClassifier	$\mathbf{\Phi}^{mnx}_s$	0.9061
		$\mathbf{\Phi}'^{mnx}_s$	0.9241
v_5	Adaptive u-net + v_4	$\mathbf{\Phi}'_s$	0.9289