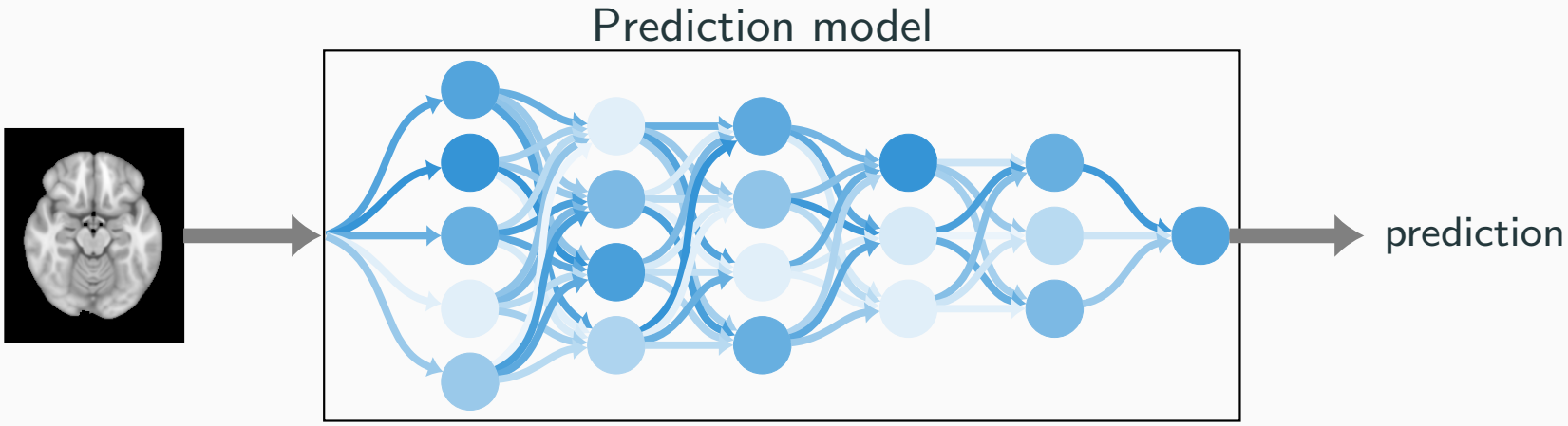
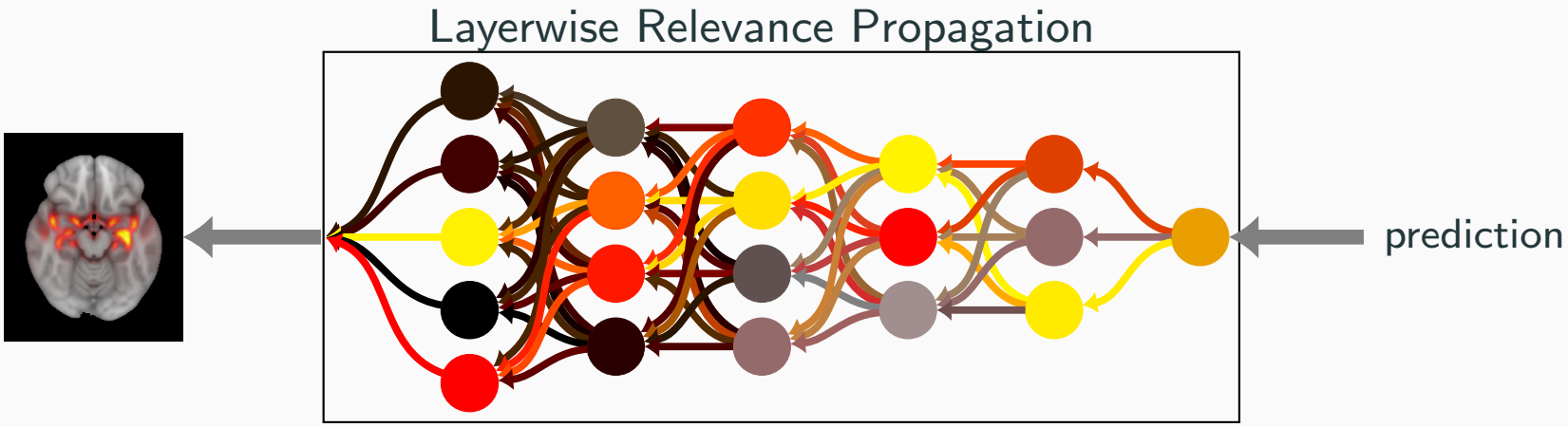
Layerwise Relevance Propagation



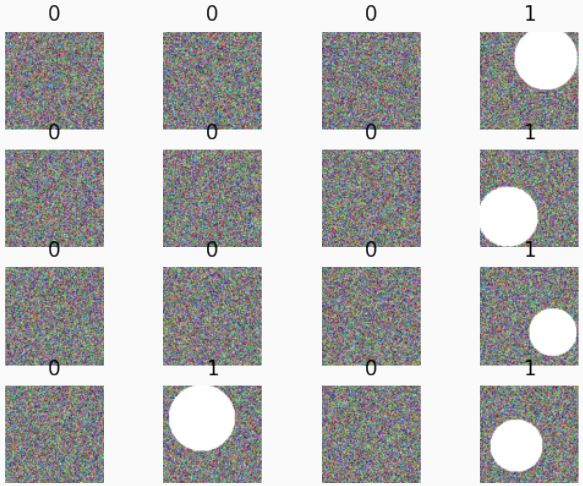
$$n_{i,j} = \sum_k n_{i-1,k} w_{k,j}$$

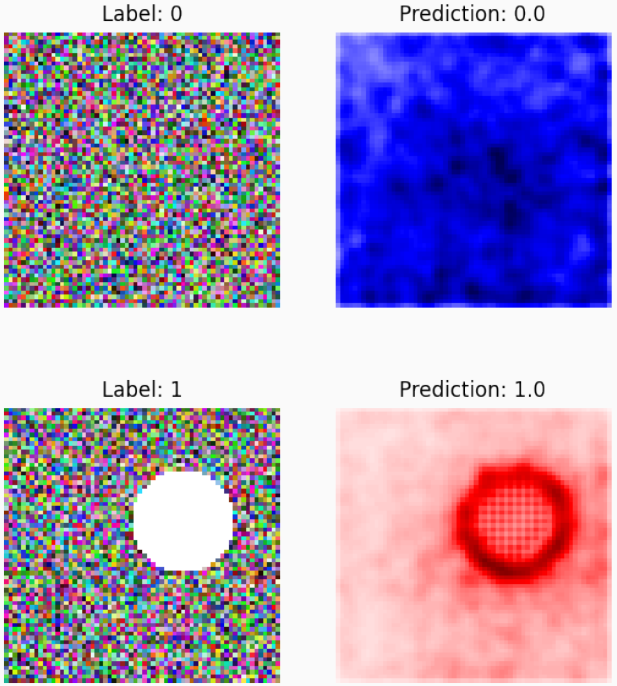
Layerwise Relevance Propagation



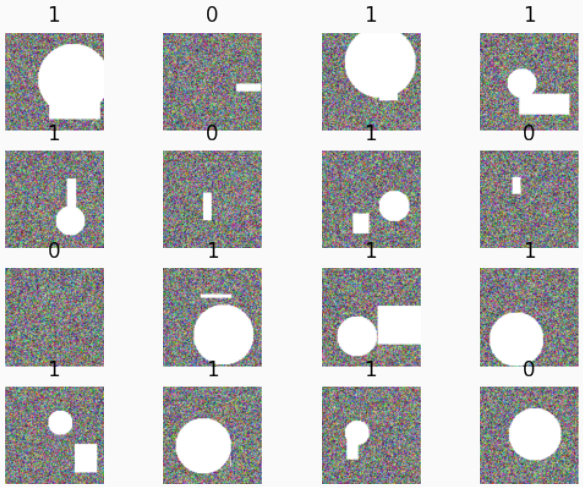
$$n_{i,j} = \sum_k n_{i-1,k} w_{k,j} \quad R_{i,j} = \sum_k \frac{max(0, a_j w_{j,k})}{\sum_l max(0, a_l w_{l,k})} R_{i+1,k}$$

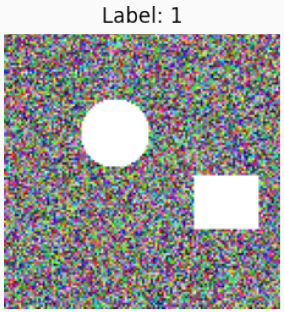
Layerwise Relevance Propagation

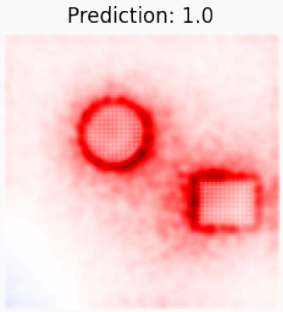


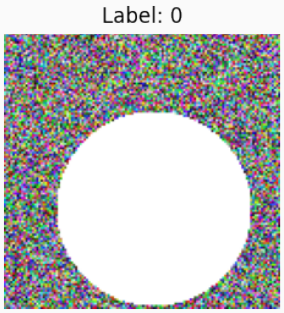


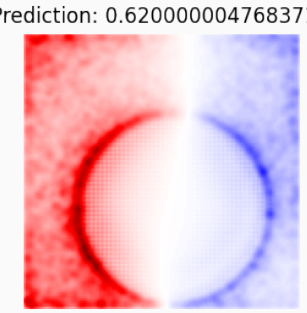
Layerwise Relevance Propagation

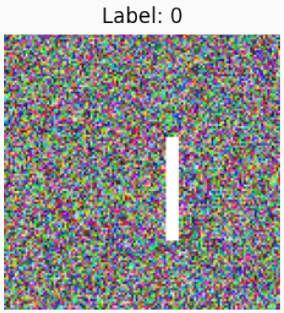


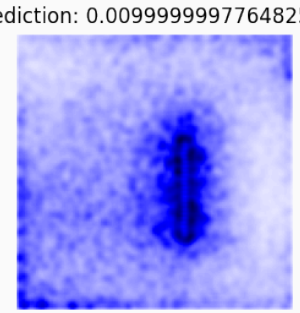




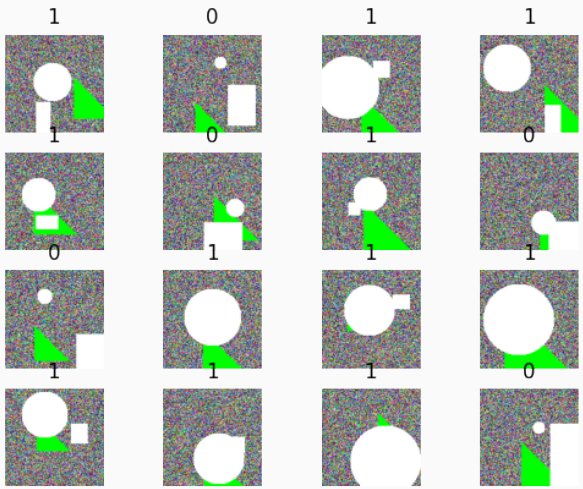


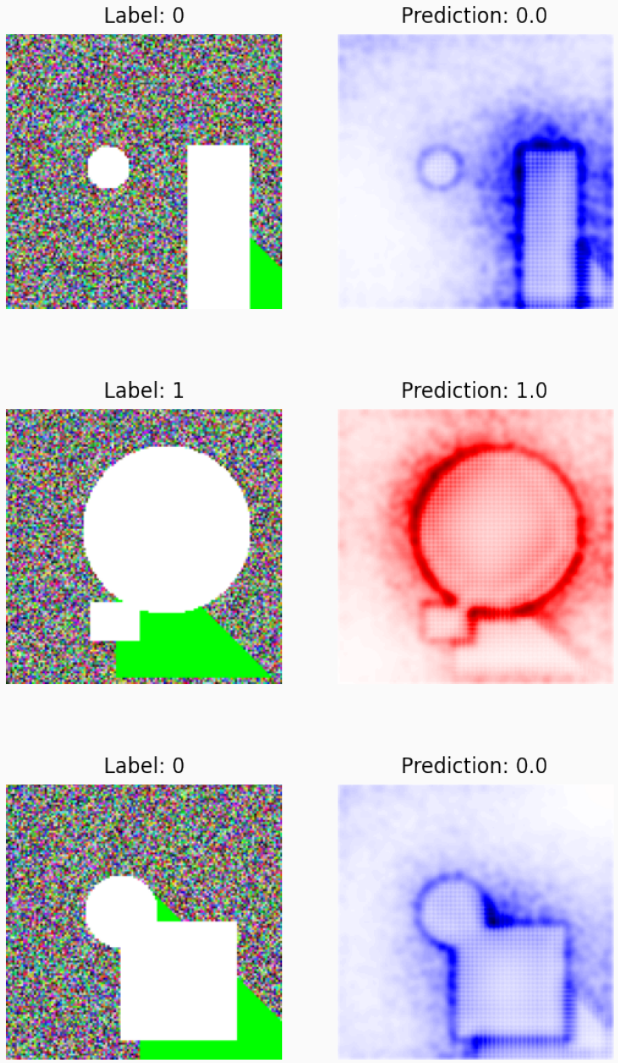




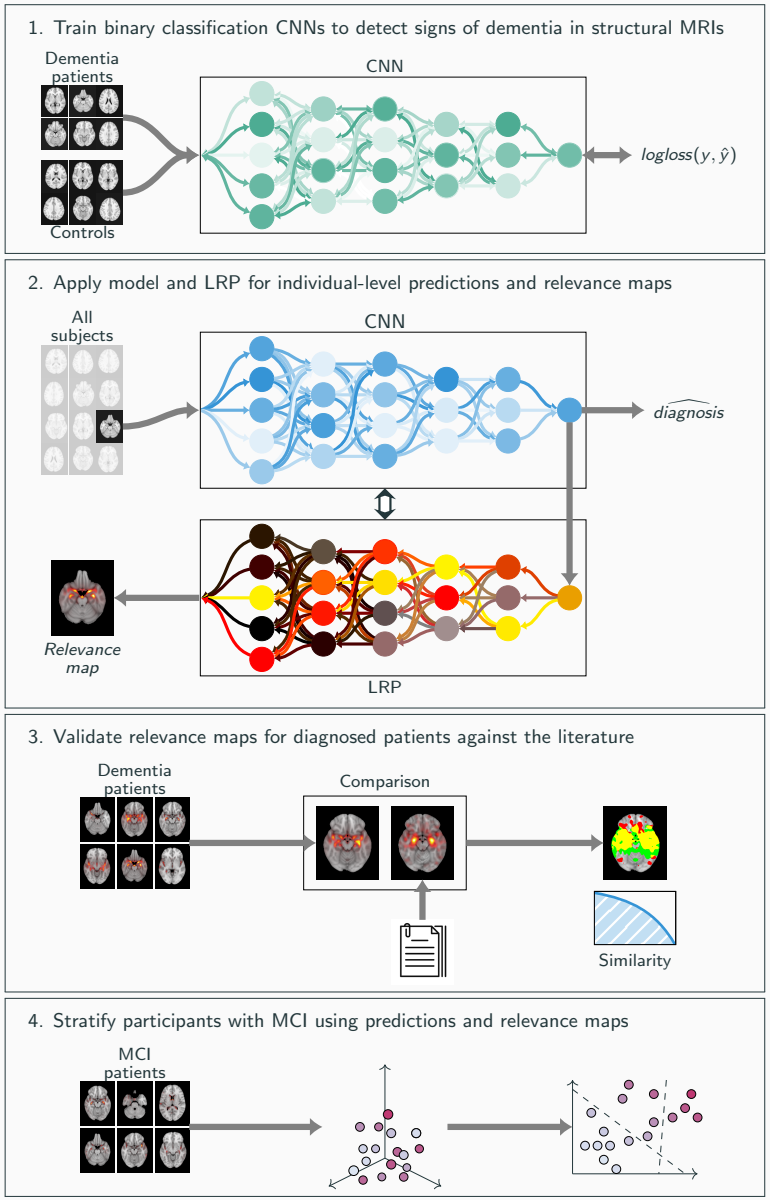


Layerwise Relevance Propagation



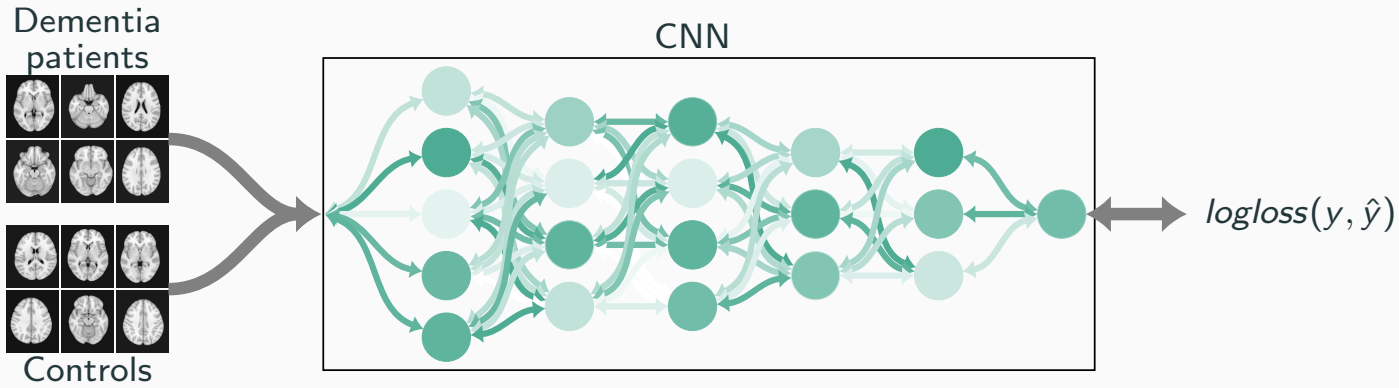


Overview

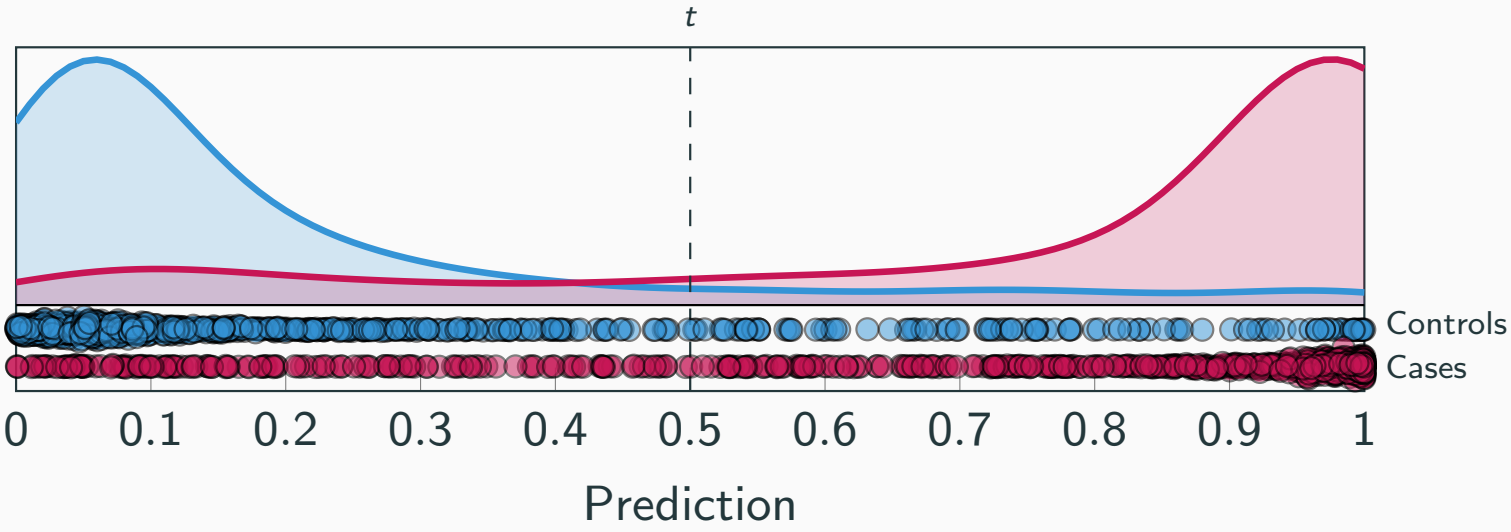

1. Train binary classification CNNs to detect signs of dementia in structural MRIs
Dementia patients
Controls
CNN
$logloss(y, \hat{y})$
2. Apply model and LRP for individual-level predictions and relevance maps
All subjects
CNN
$\widehat{diagnosis}$
Relevance map
LRP
3. Validate relevance maps for diagnosed patients against the literature
Dementia patients
Comparison
Similarity
4. Stratify participants with MCI using predictions and relevance maps
MCI patients

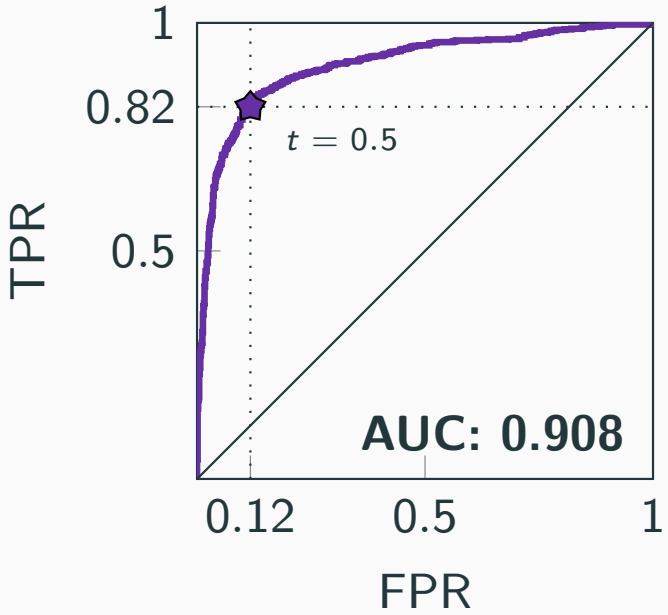
Case-control predictions

1. Train binary classification CNNs to detect signs of dementia in structural MRIs



Case-control predictions

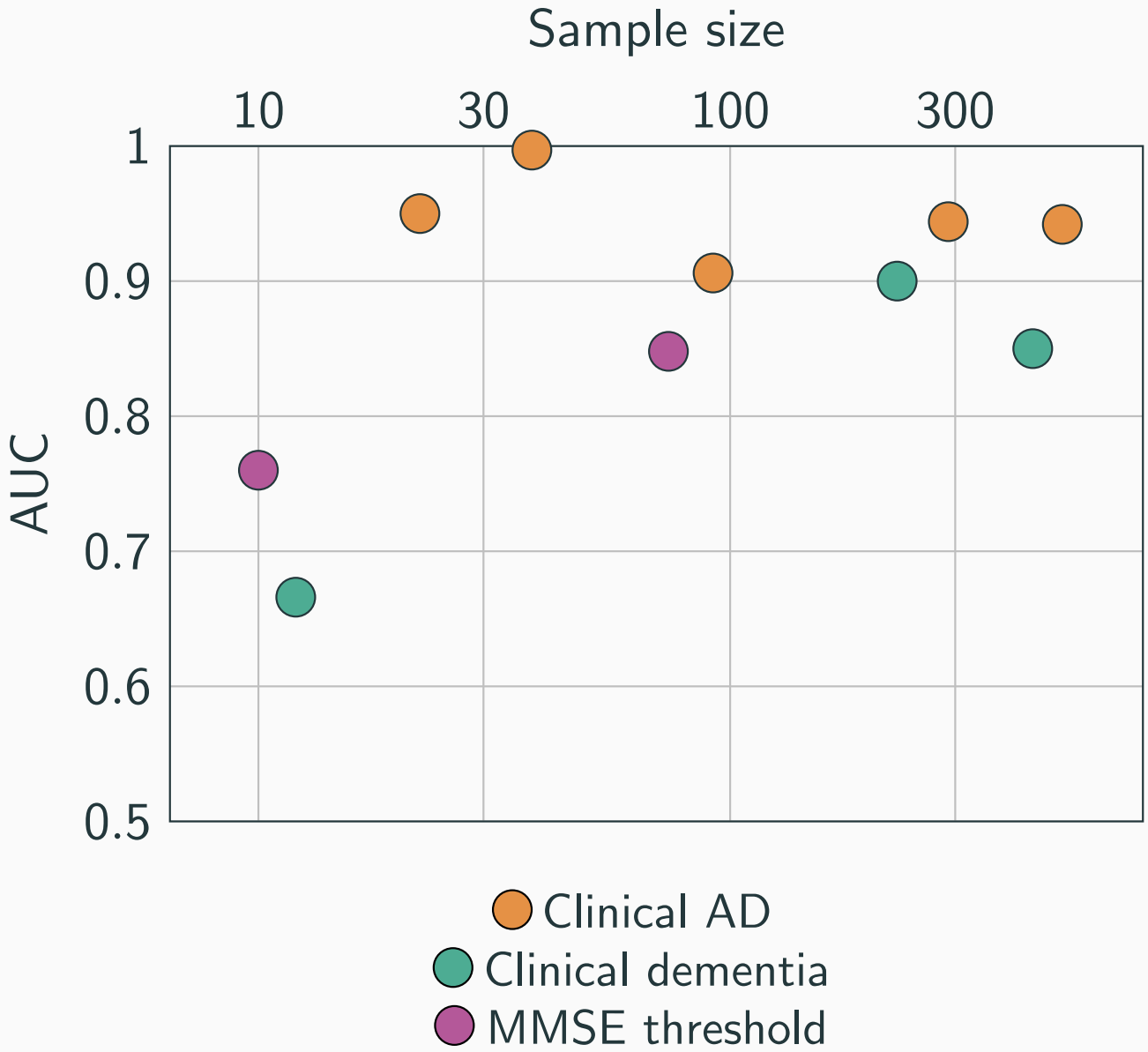




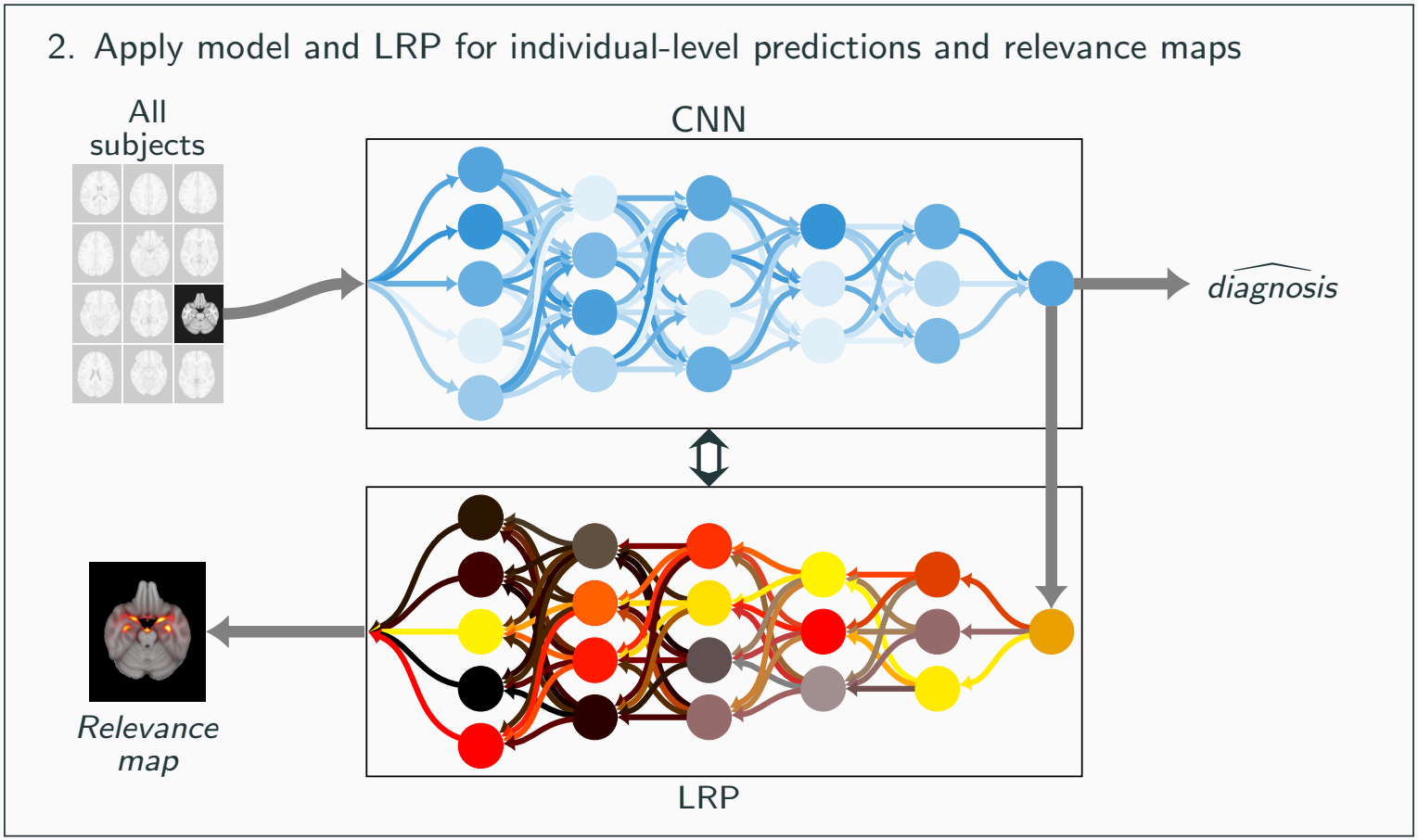
		Predicted	
		0	**1**
Observed	**0**	754	100
	1	157	697

Accuracy: 84.95%

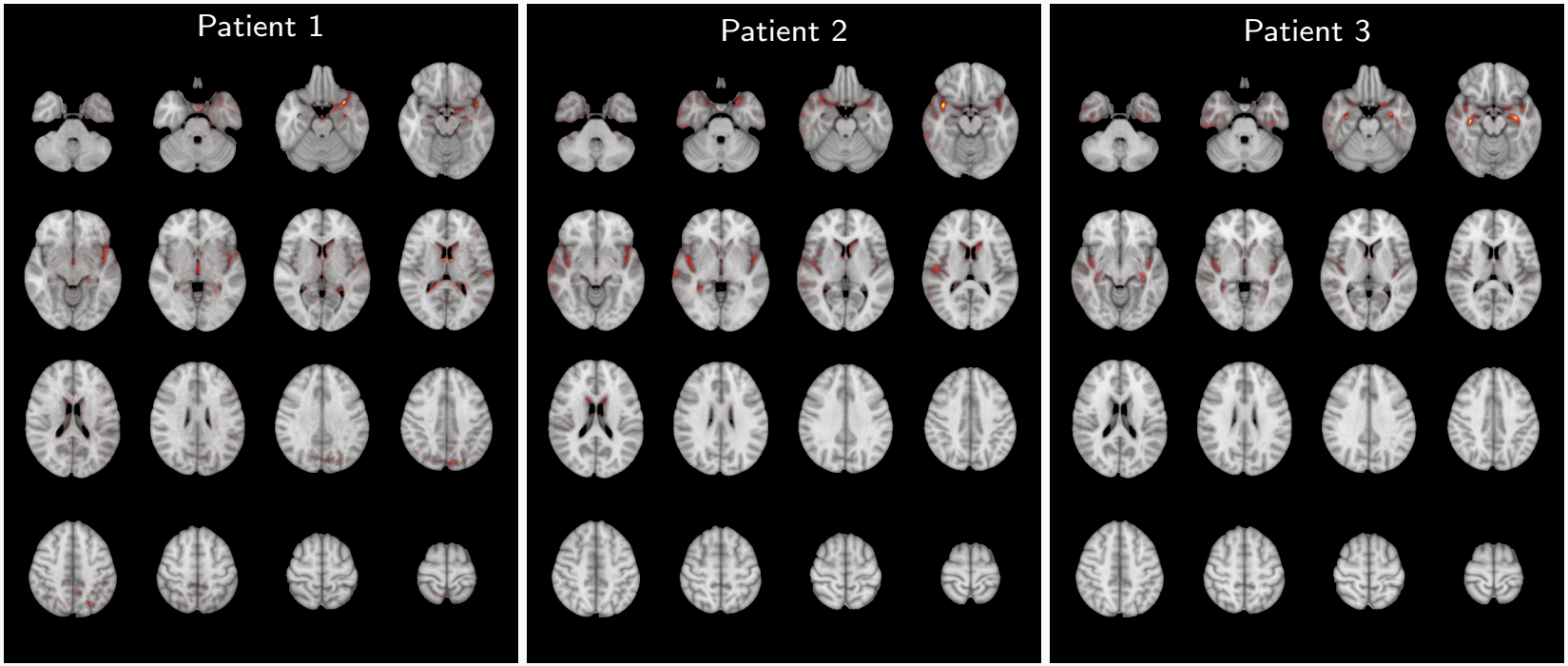
Case-control predictions



Generating relevance maps

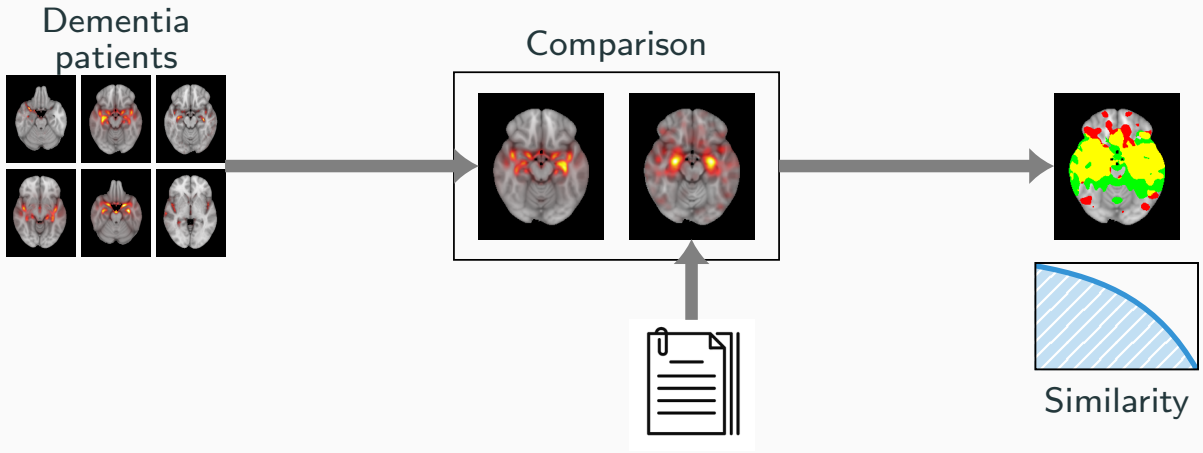


Generating relevance maps



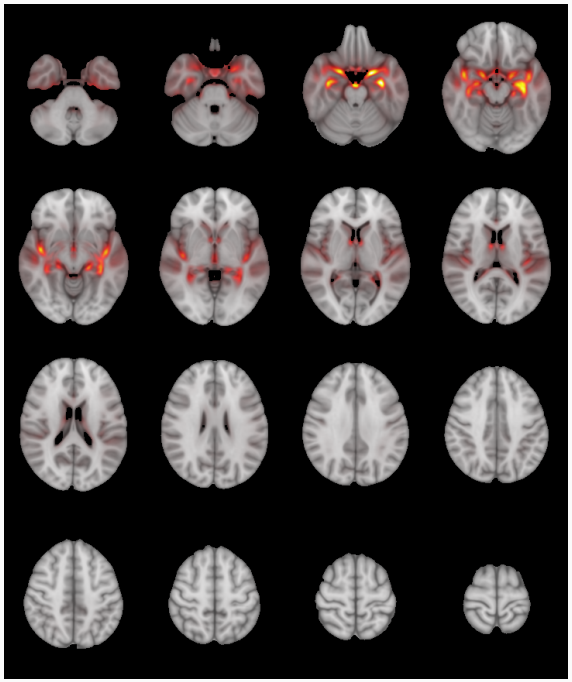
Validating relevance maps in dementia patients

3. Validate relevance maps for diagnosed patients against the literature

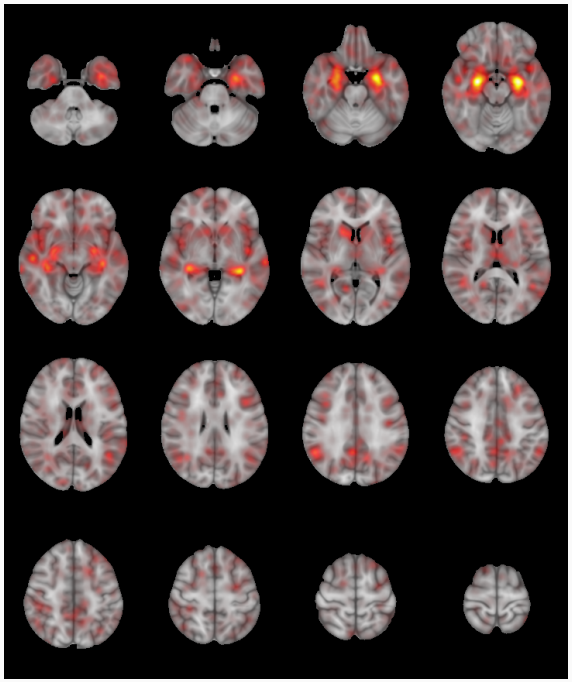


Validating relevance maps in dementia patients

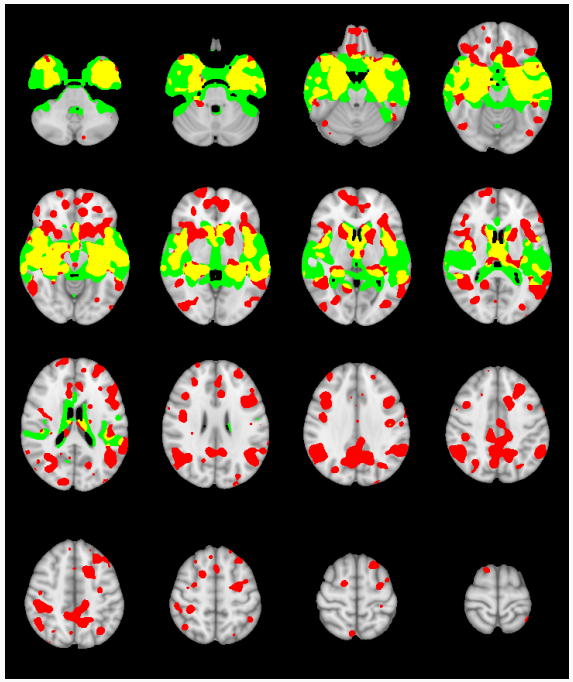
Average dementia patient



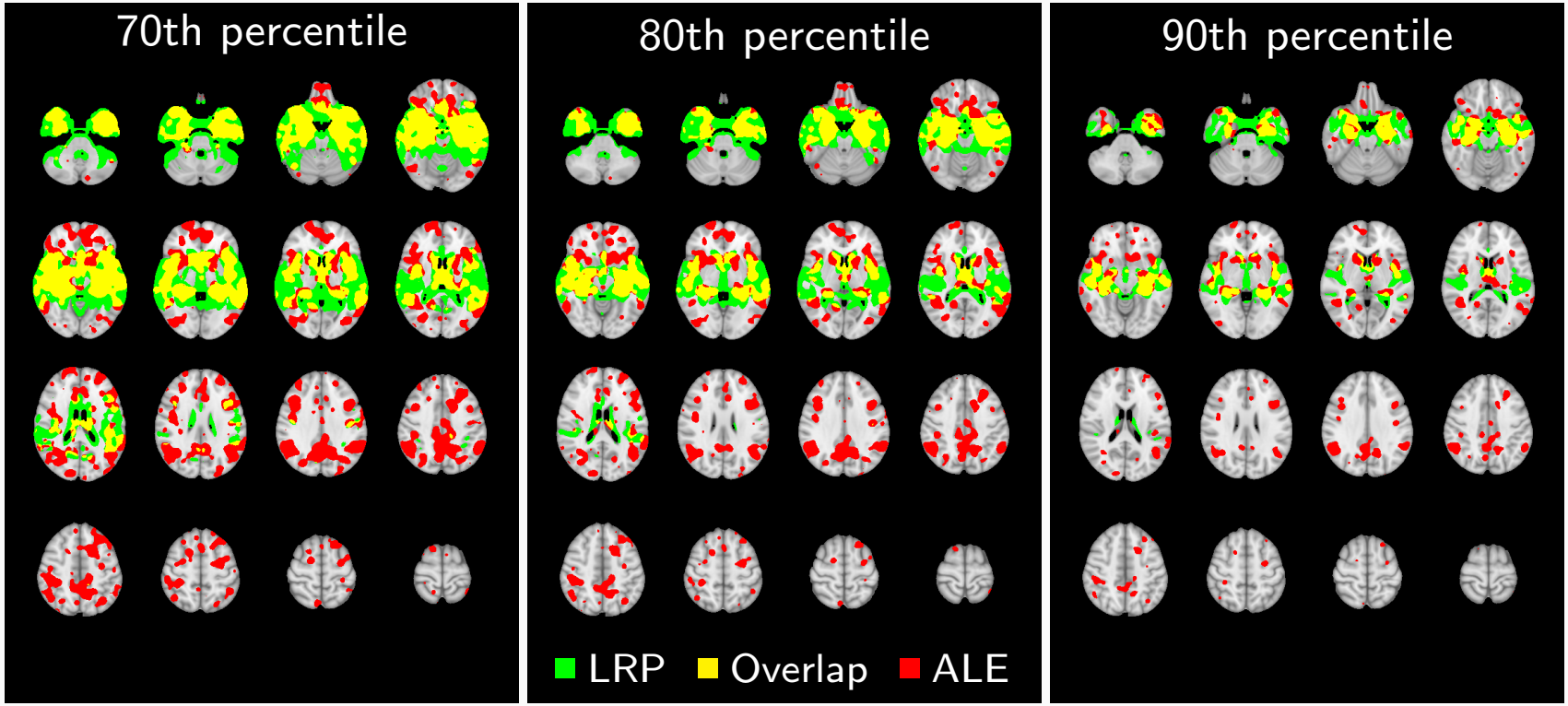
GingerALE meta-analysis



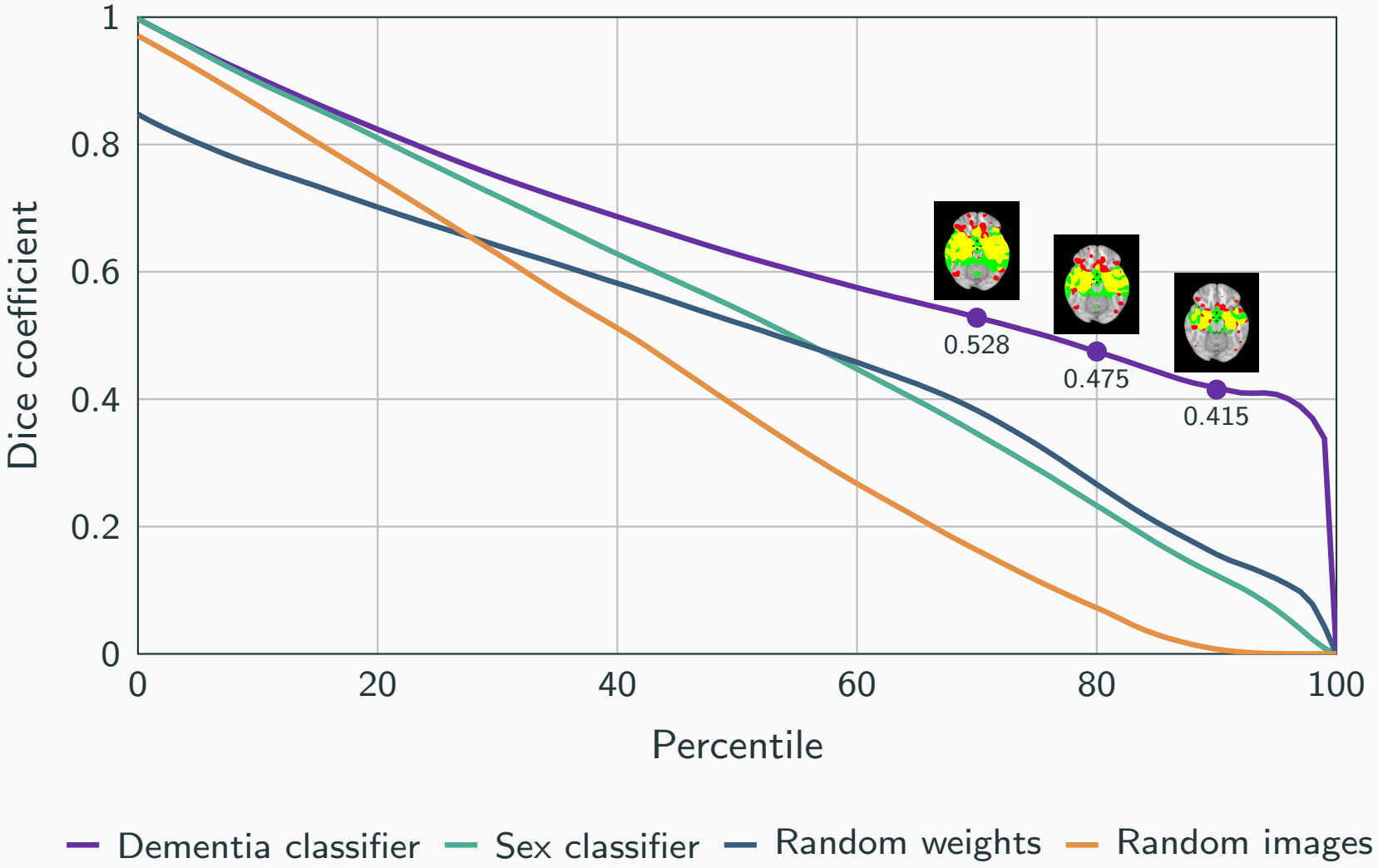
Overlap



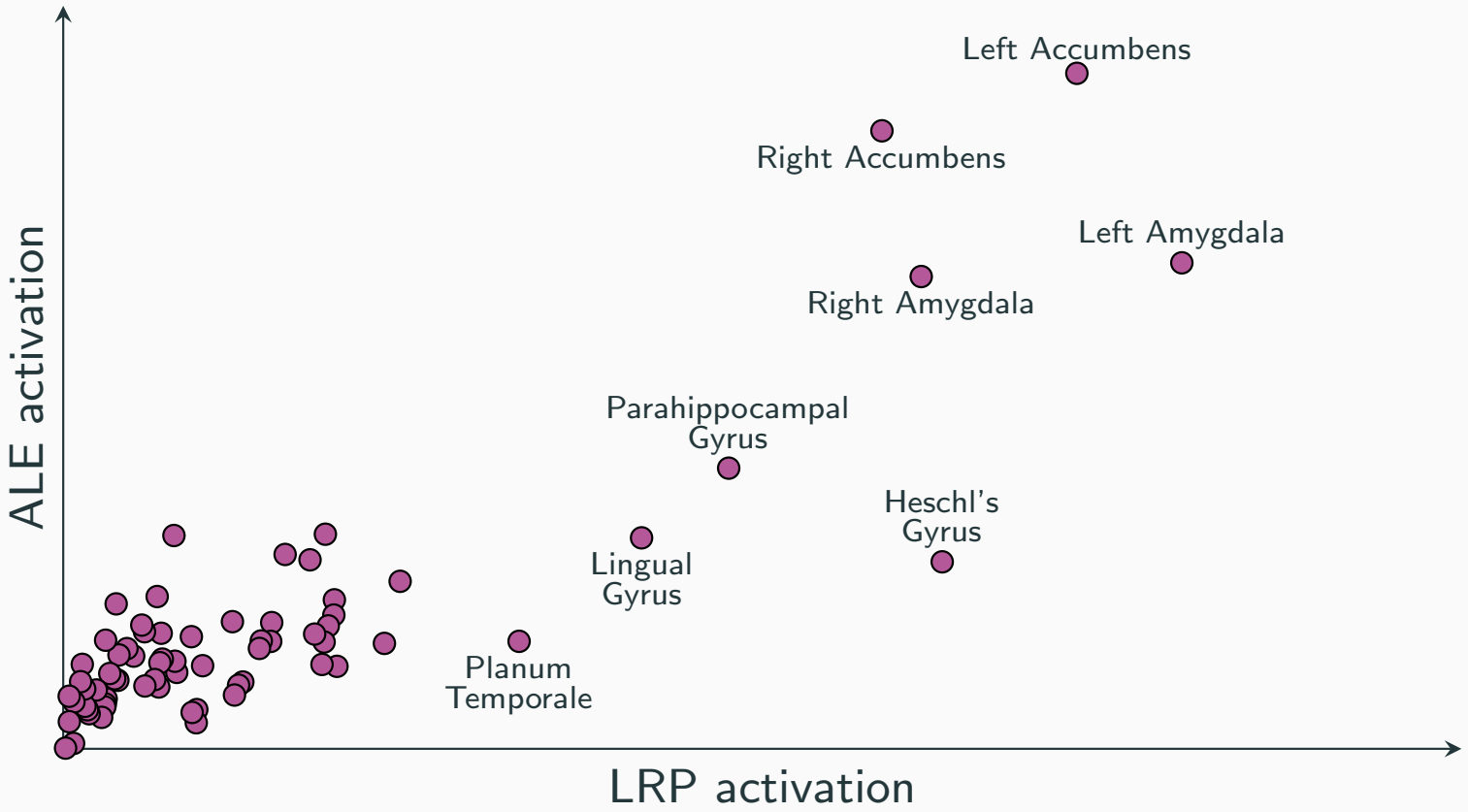
Validating relevance maps in dementia patients



Validating relevance maps in dementia patients

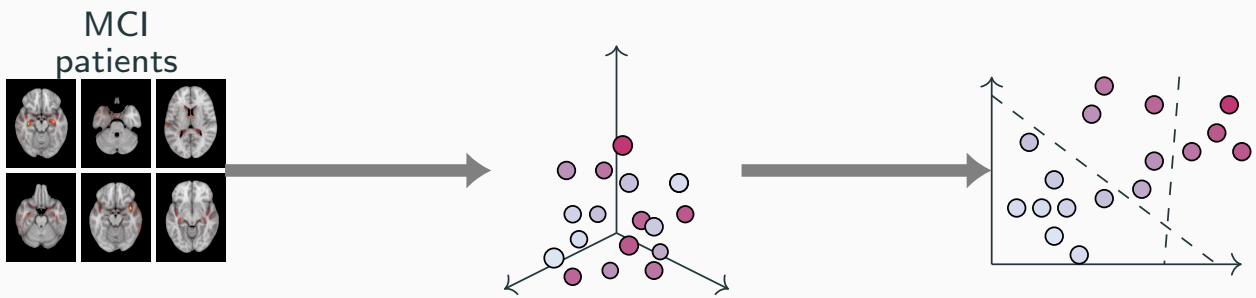


Validating relevance maps in dementia patients

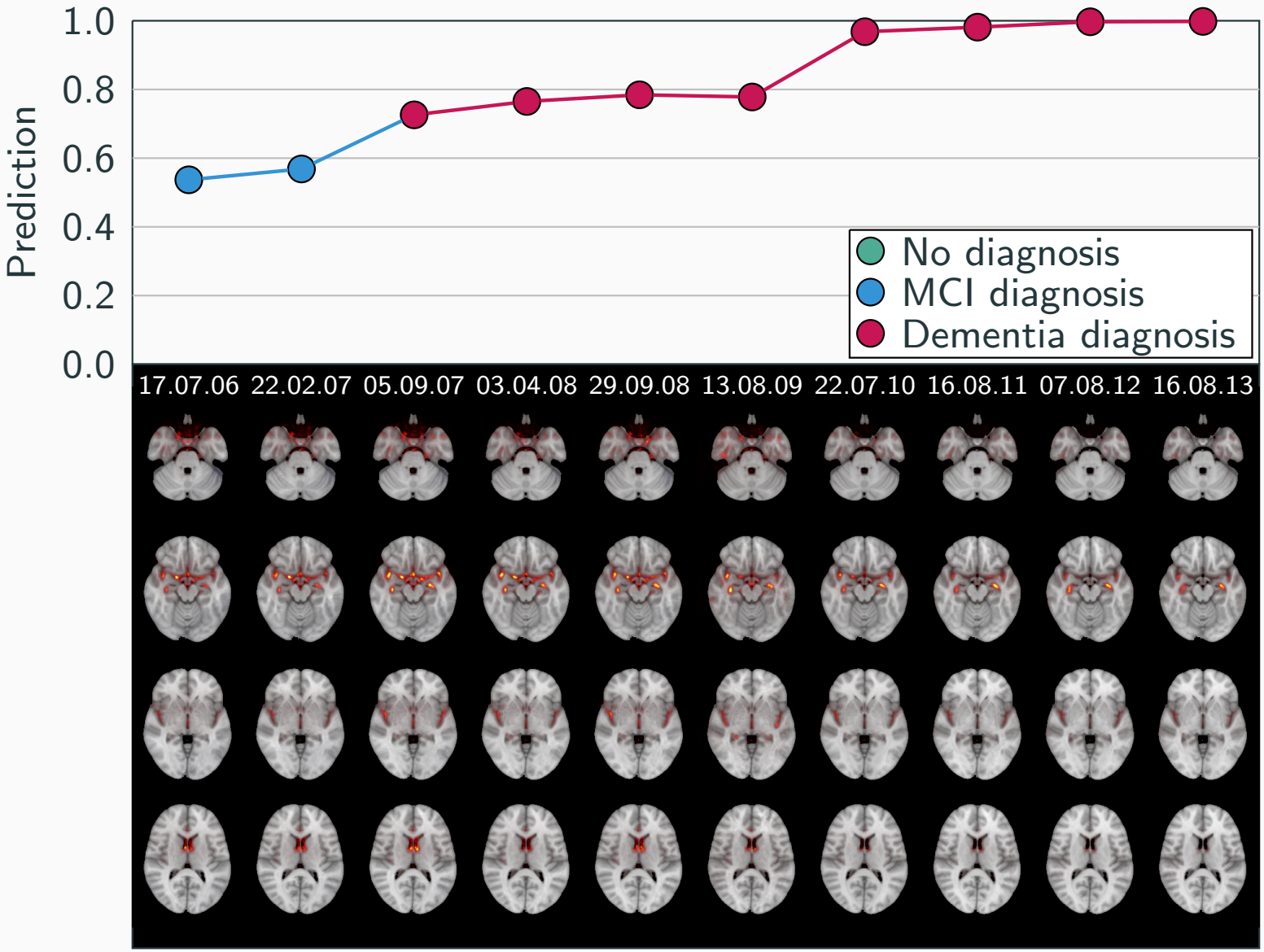


Exploring relevance maps in MCI patients

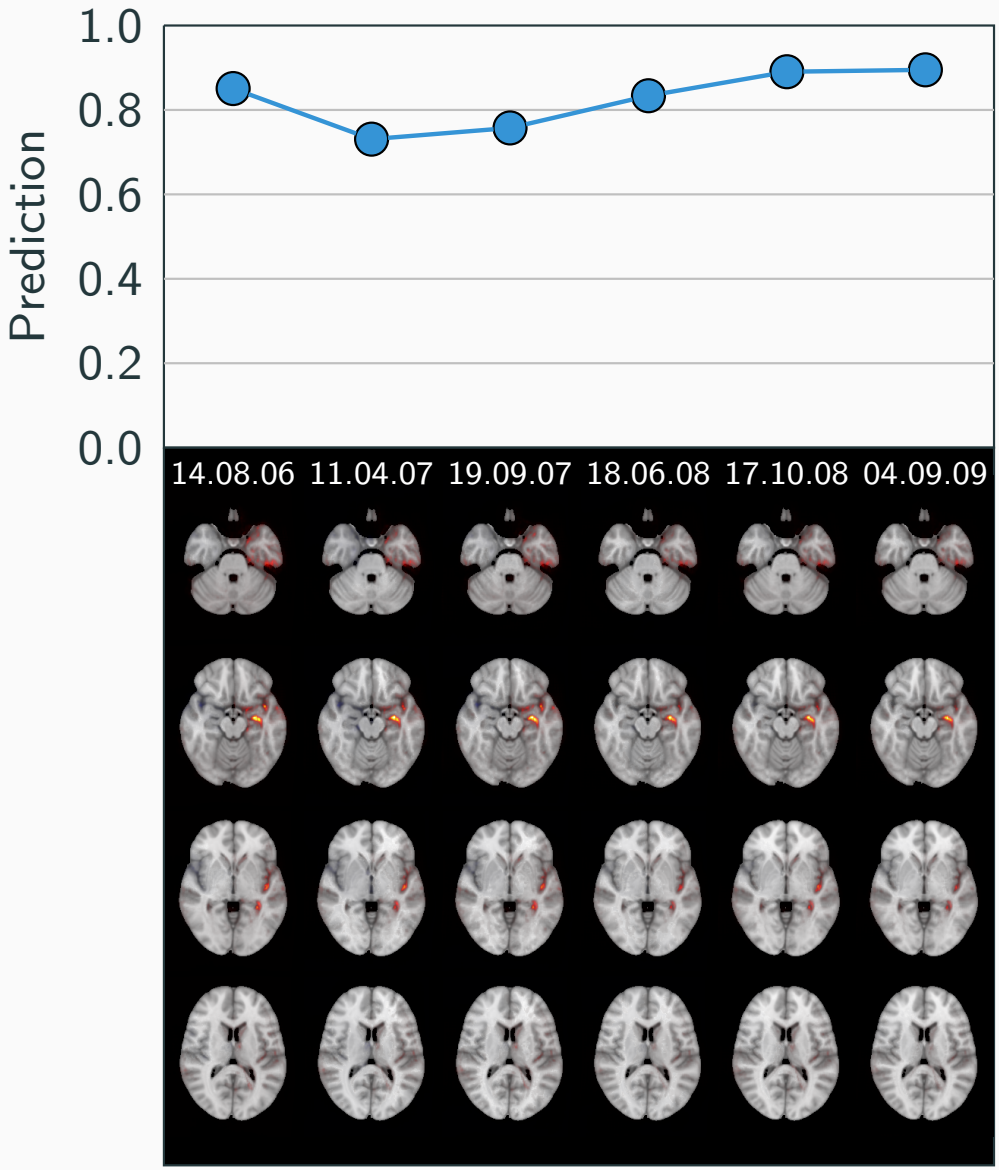
4. Stratify participants with MCI using predictions and relevance maps



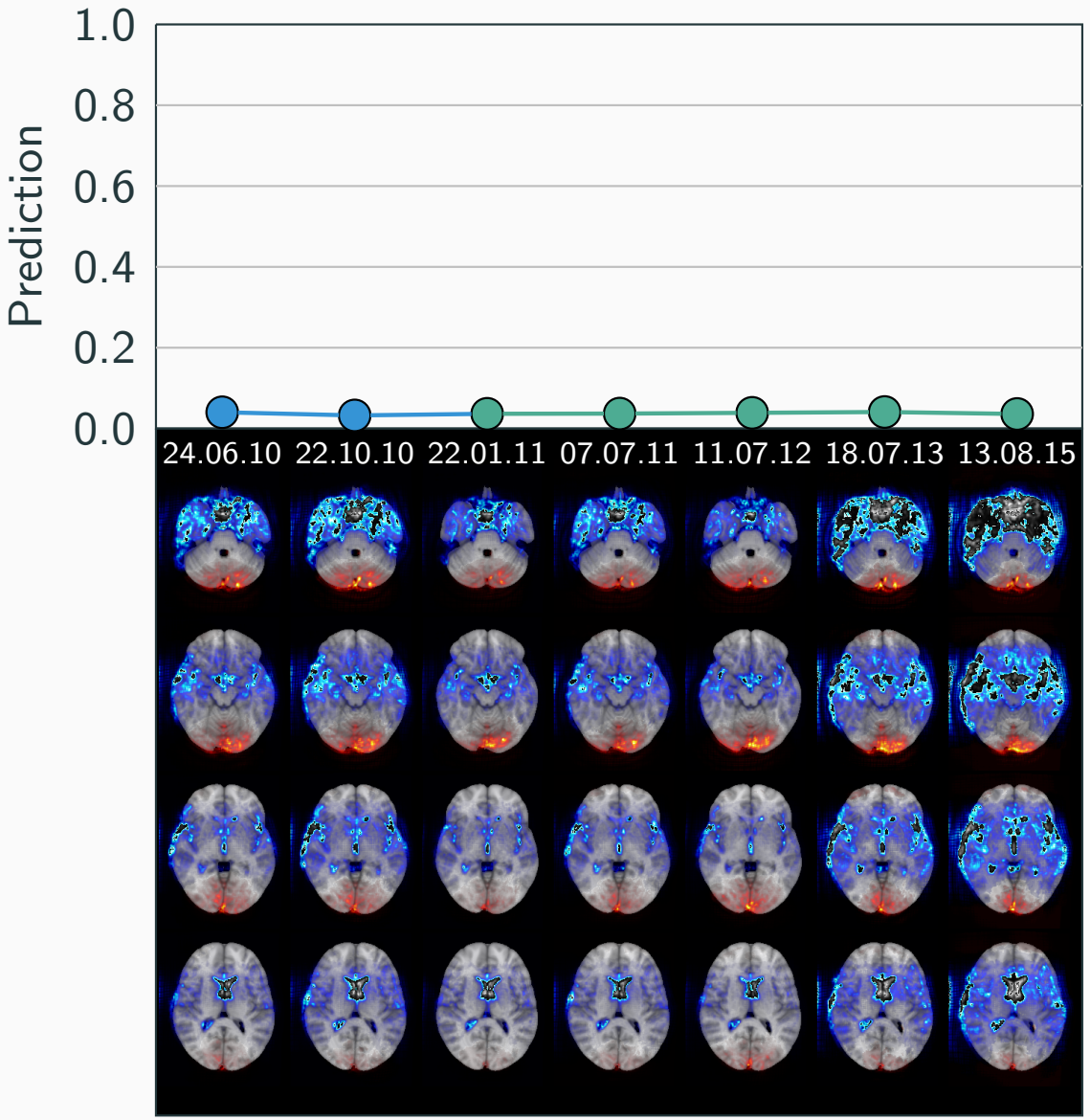
Exploring relevance maps in MCI patients



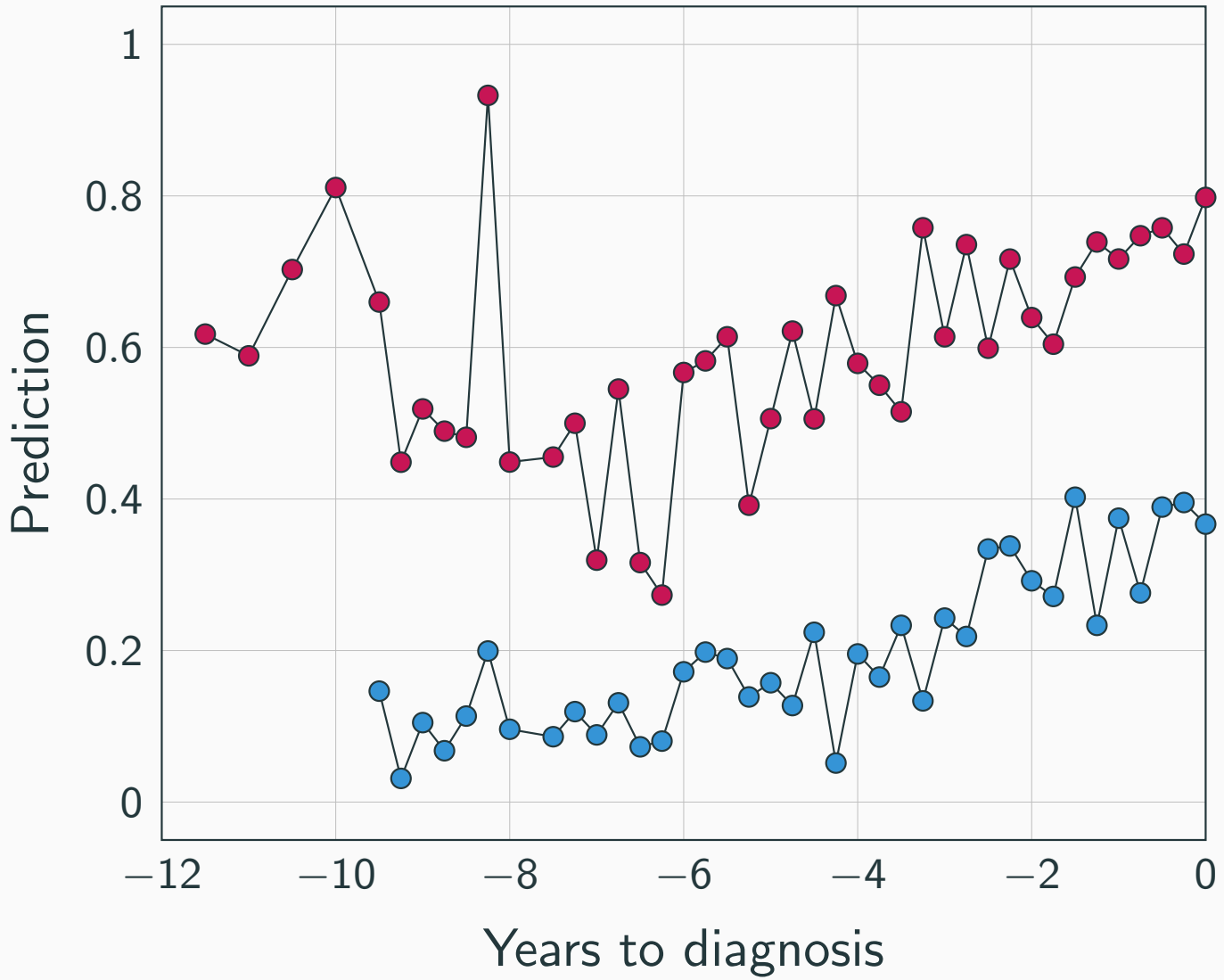
Exploring relevance maps in MCI patients



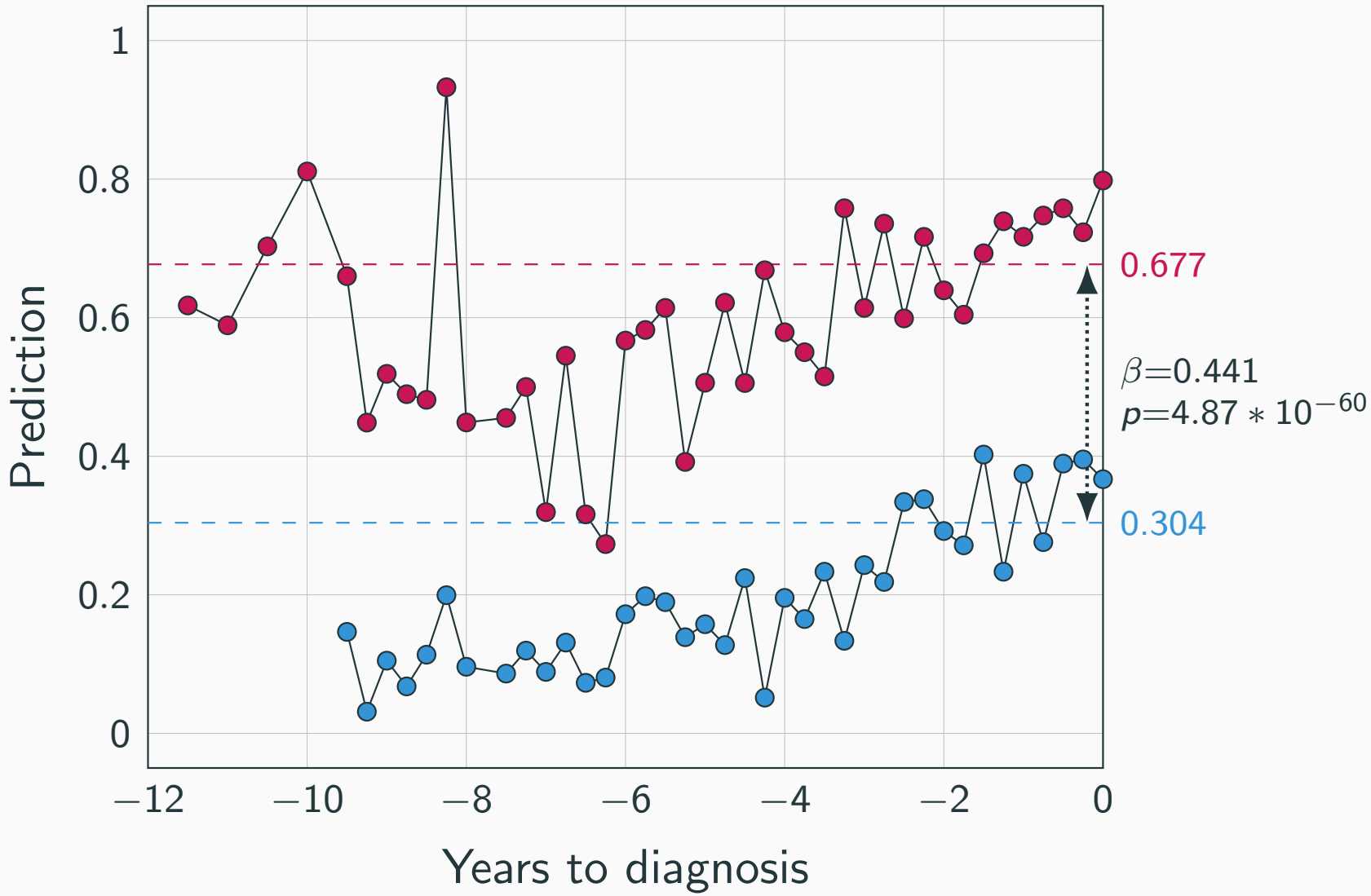
Exploring relevance maps in MCI patients



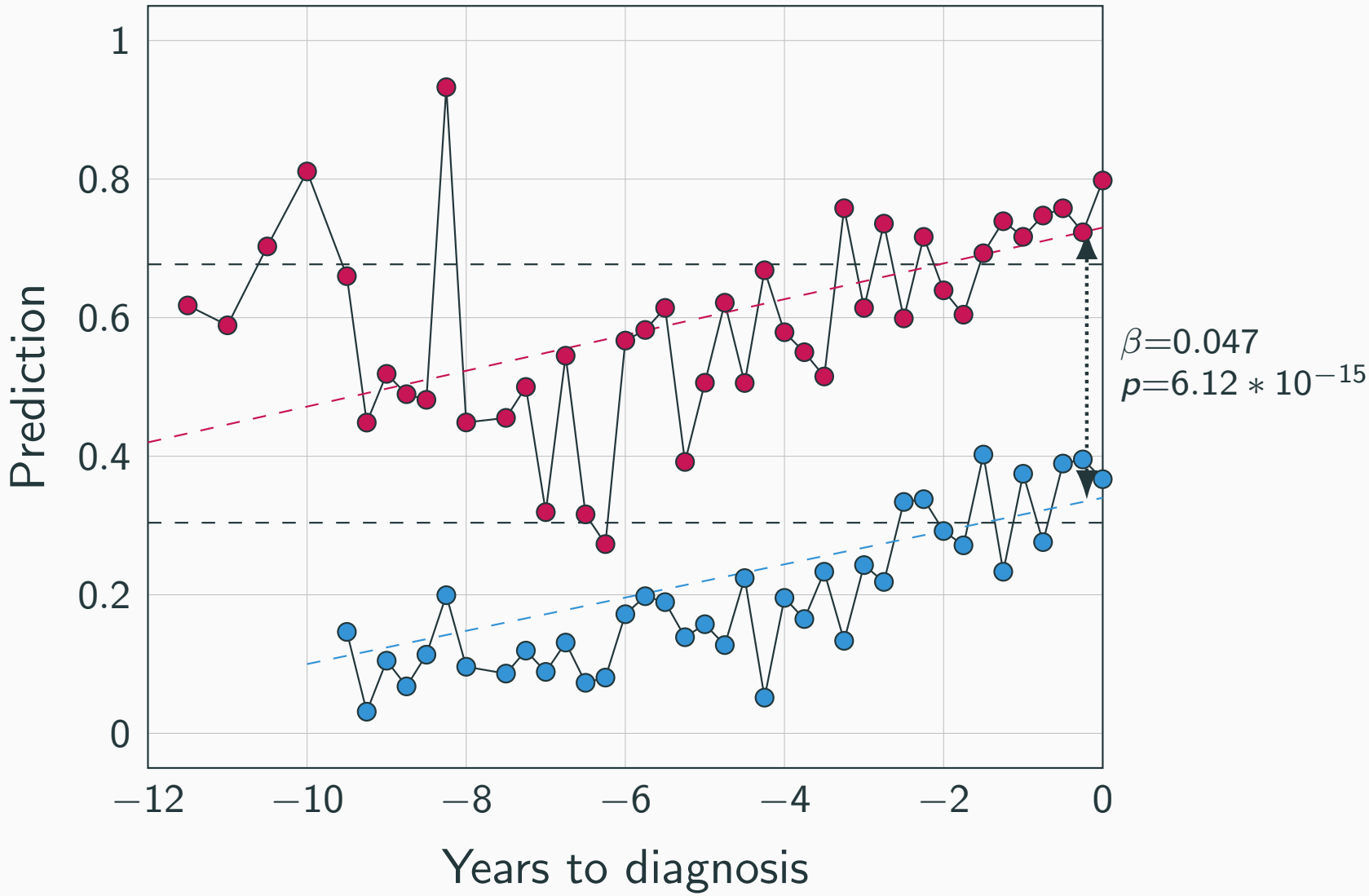
Exploring relevance maps in MCI patients



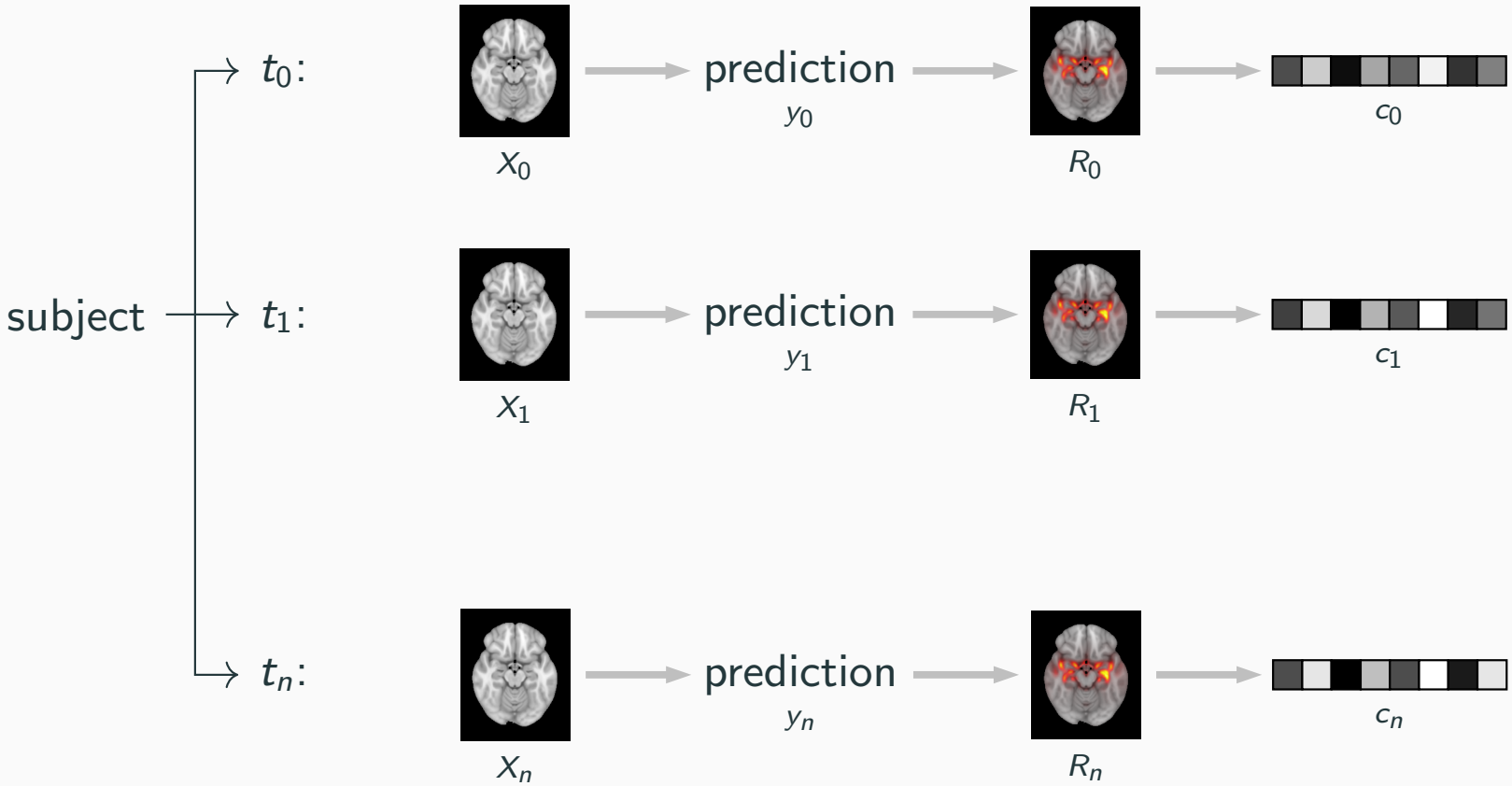
Exploring relevance maps in MCI patients



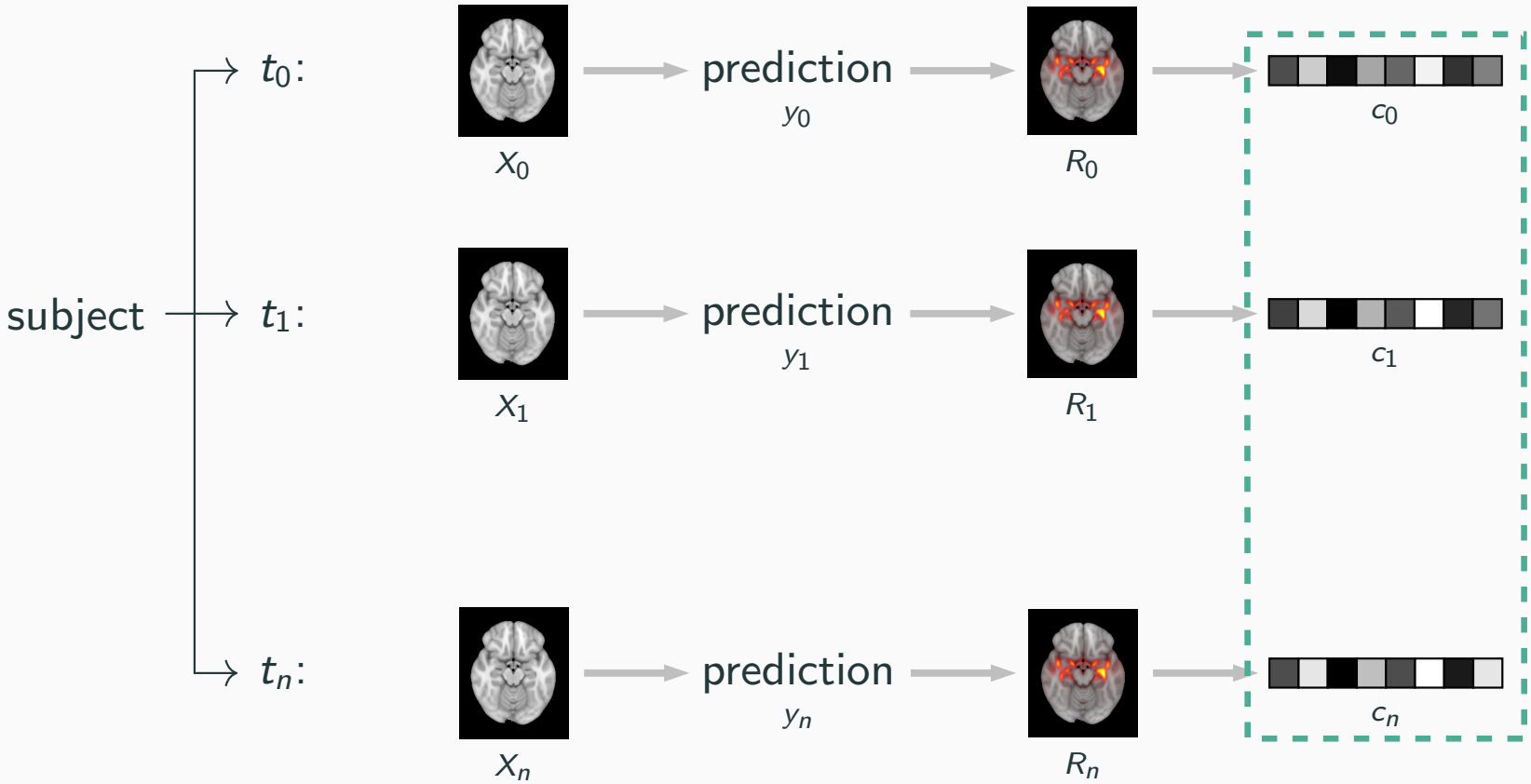
Exploring relevance maps in MCI patients



Exploring relevance maps in MCI patients

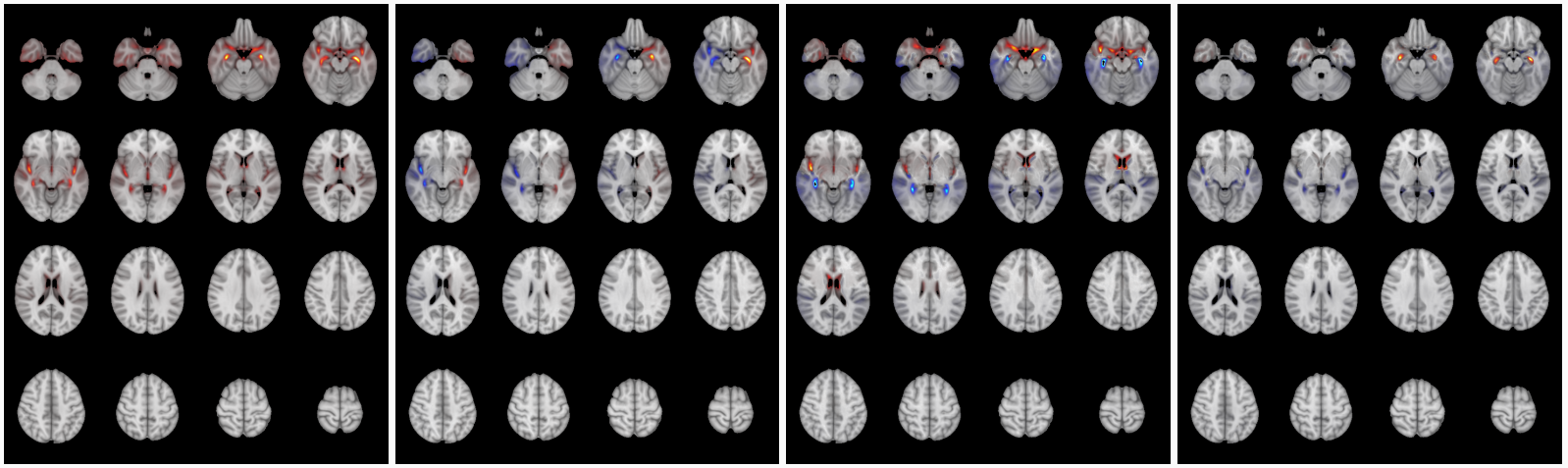


Exploring relevance maps in MCI patients

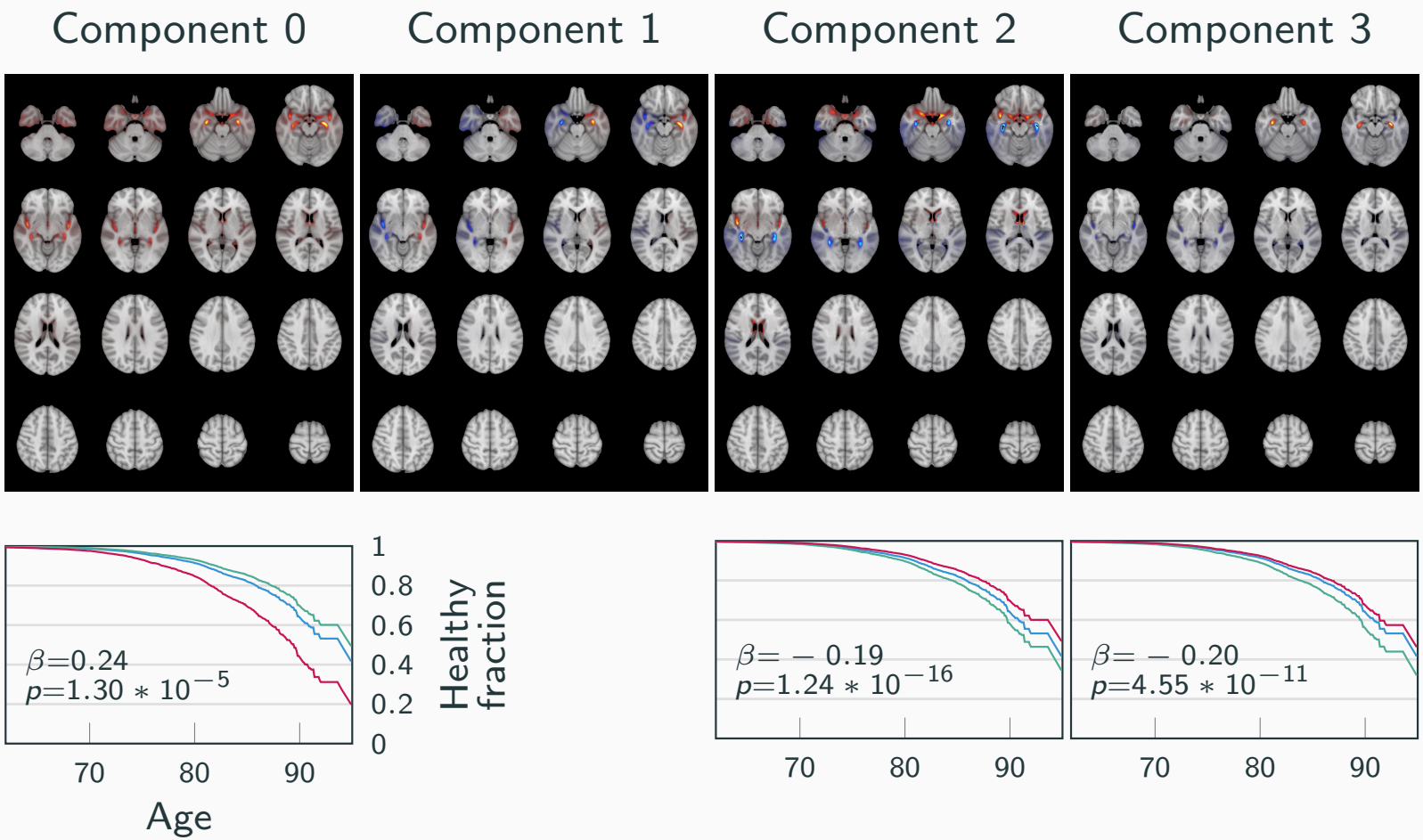


Exploring relevance maps in MCI patients

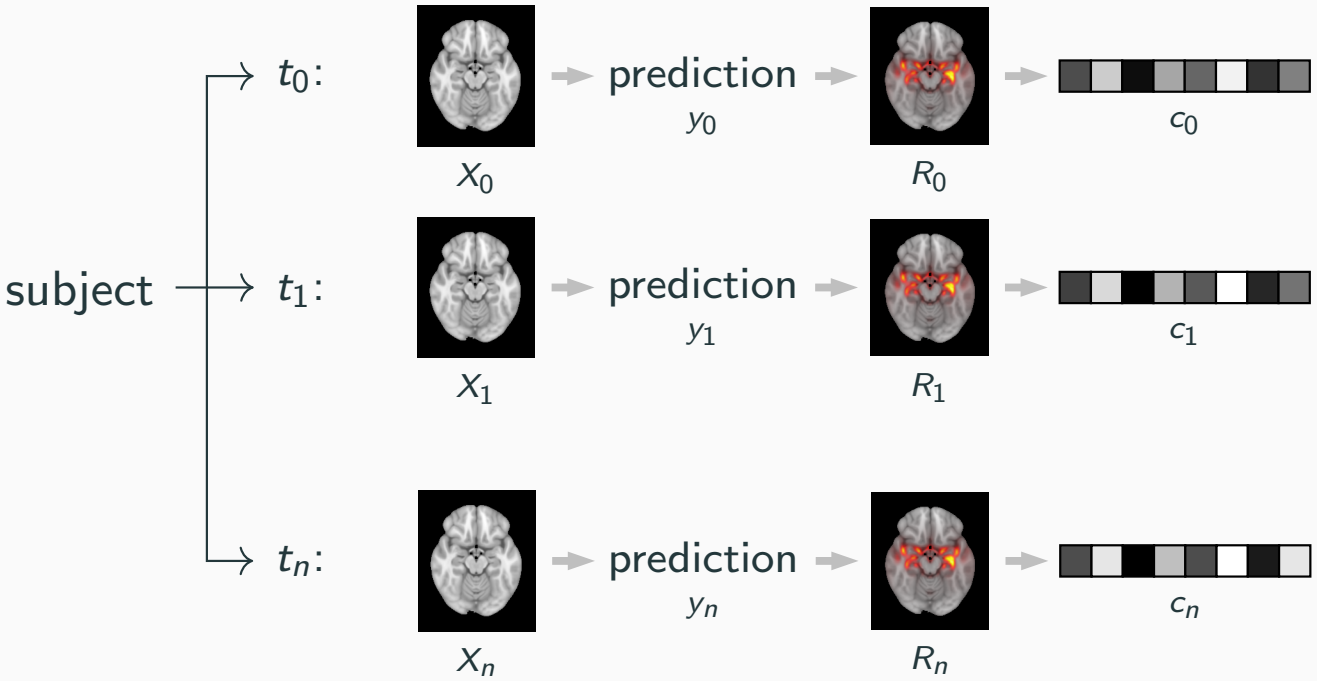
Component 0 Component 1 Component 2 Component 3



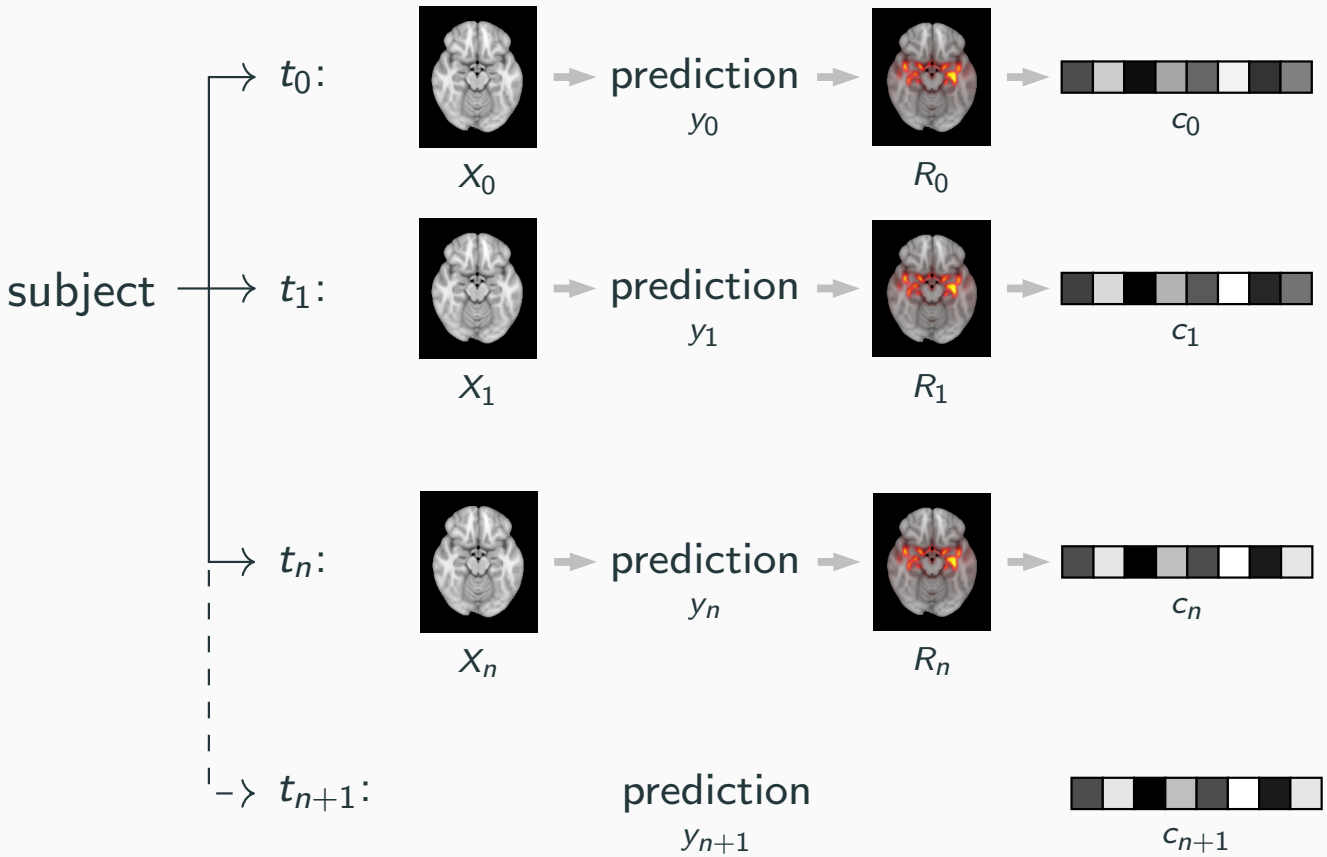
Exploring relevance maps in MCI patients



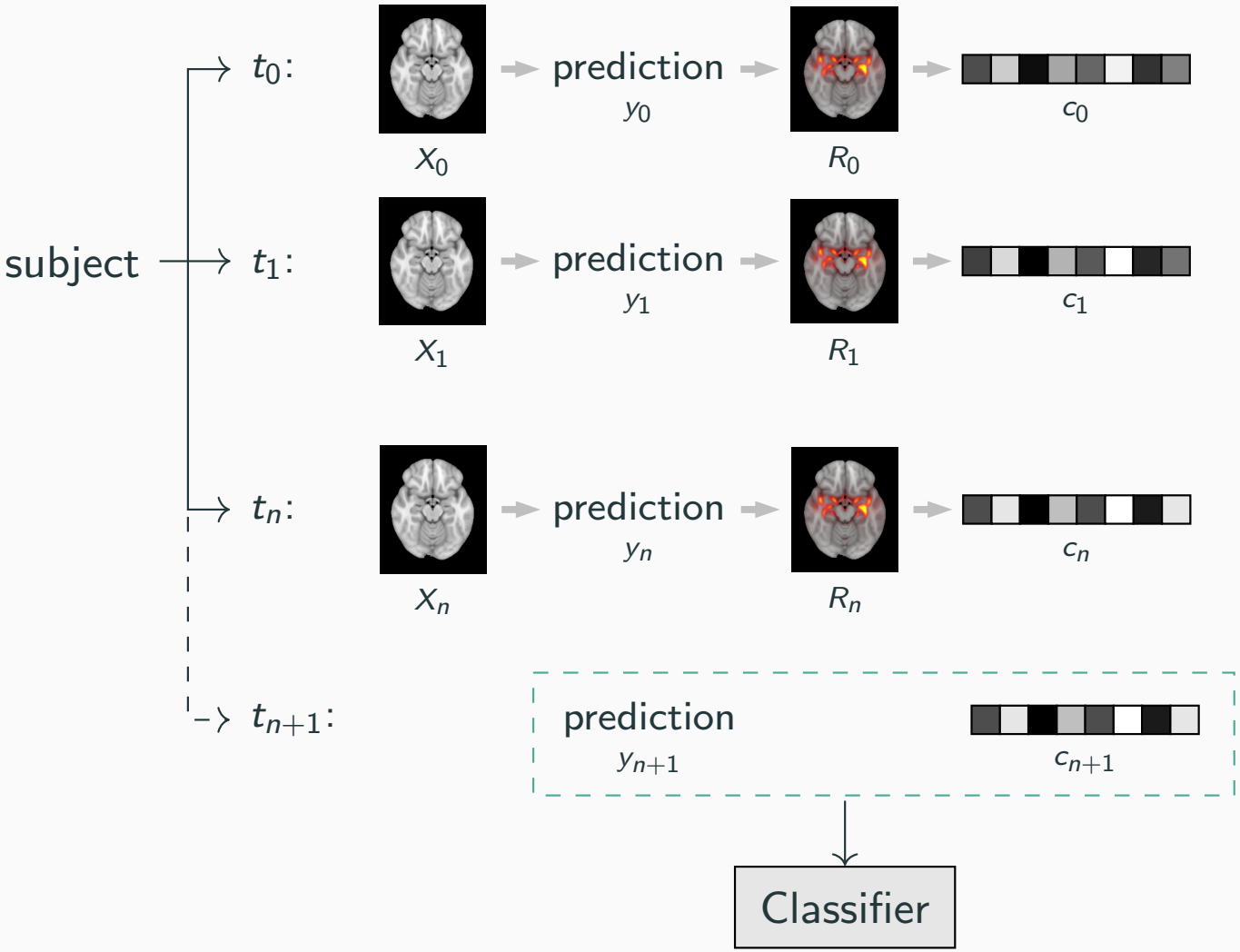
Exploring relevance maps in MCI patients



Exploring relevance maps in MCI patients



Exploring relevance maps in MCI patients



Exploring relevance maps in MCI patients

Covariates	AUC	Accuracy	PPV	Sensitivity	Specificity
$\text{progression}_{n+1} \sim \text{age} + \text{sex}$	0.521 ± 0.029	51.57 ± 3.56	0.61 ± 0.03	0.66 ± 0.03	0.37 ± 0.04
$\text{progression}_{n+1} \sim \text{age} + \text{sex} + \hat{y}_n$	0.806 ± 0.028	75.29 ± 2.67	0.84 ± 0.03	0.72 ± 0.03	0.79 ± 0.04
$\text{progression}_{n+1} \sim \text{age} + \text{sex} + \hat{y}_n + c_n$	0.816 ± 0.029	76.12 ± 2.71	0.83 ± 0.03	0.76 ± 0.03	0.76 ± 0.04
$\text{progression}_{n+1} \sim \text{age} + \text{sex} + \hat{y}_{n+1} + c_{n+1}$	0.830 ± 0.027	77.18 ± 2.62	0.82 ± 0.02	0.80 ± 0.03	0.74 ± 0.04

Exploring relevance maps in MCI patients

"There is an X% chance the patient will progress into dementia by date XX.YY.ZZZZ based on existing pathology in brain regions A, B and C, and an expected increase/decrease of pathology in regions D and E."