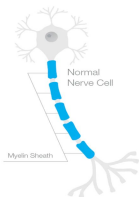




## Background

Multiple sclerosis (MS) is a disease of the central nervous system, where the immune system attacks the protective myelin sheath, causing complications within internal communications.



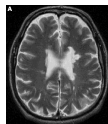
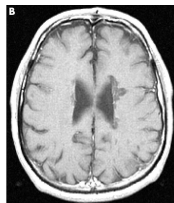
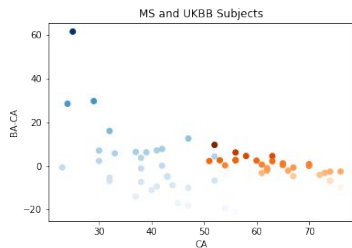
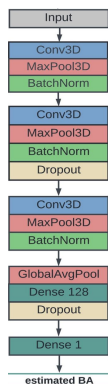
## Research Question

Can the difference between Brain Age (BA) estimations and Chronological Age (CA) reveal the extent of neural degeneration as a result of MS?

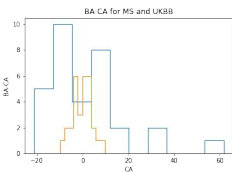
## Methods

### (1) BA estimation by an interpretable 3D-CNN

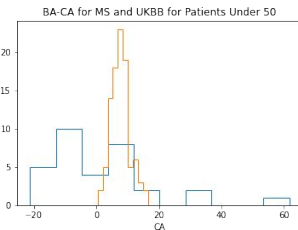
Phenotypic age, revealed via deep learning of T1 weighted MRIs, contain indicators of structural change within the cortical structure related to cognitive decline.



### (2) Statistical analysis



The datasets overlapped primarily between the ages of 30-50.



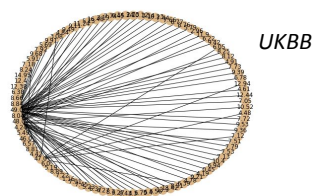
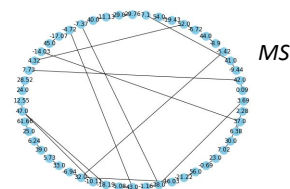
Median Differences  
MS: -0.93  
UKBB50: 7.51

### (3) Network graphs for similarity

Certain BA-CA values were common within subjects across both MS and UKBB subjects.

BA-CA	CON
47.0	3
32.0	3
38.0	3

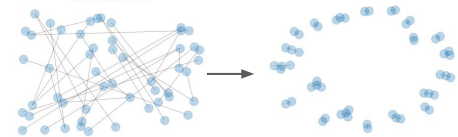
BA-CA	CON
49.0	54
48.0	29
47.0	11



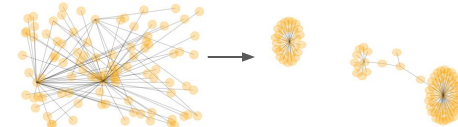
### (4) Louvain Method of community detection

This method detects communities in large networks by maximizing a modularity score.

MS



UKBB Under 50



## Results

- MS patients demonstrate higher levels of cognitive decline with more significant BA-CA differences in severely diseased patients. Alternatively, moderately diseased patients appear to suffer a similar decline to their healthy counterparts.
- This could suggest that the 3D-CNN model is not equipped to handle moderate MS. However, inclusion of the Cortical Myelination pipeline may improve results for MS.
- The model was tested previously on Alzheimer's patients which is a demyelinating disease. MS and related diseases are not the sole contributors of cognitive decline via a change in cortical structure.

## References

M Muslim, Ali (2022), "Brain MRI Dataset of Multiple Sclerosis with Consensus Manual Lesion Segmentation and Patient Meta Information", *Mendeley Data*, V1, doi: 10.17632/8bctsmj7.1.  
Yin, Chenzhong, et al. "Anatomically interpretable deep learning of brain age captures domain-specific cognitive impairment." *Proceedings of the National Academy of Sciences* 120.2 (2023): e2214634120.