Artificial Intelligence based detection of Parkinson's disease in Magnetic Resonance Imaging brain scans

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Background

Candidate neuroprotective treatments for PD are highlighting the **need for early diagnostic tests**.

A number of exploratory imaging techniques have suggested that **early pathological brain changes** may be detectable using dedicated experimental MRI sequences.

We explored whether **machine learning** (ML) might be employed to detect such brain changes on routine MRI scans.

A subset of ML known as **deep learning** (DL) has shown great promise in diagnostic medical imaging, sometimes matching or even exceeding the diagnostic performance of radiologists.

DL offers the potential of **automated diagnosis** by detecting patterns that might be invisible to the human eye.

DL methods have sometimes been criticised for being "black boxes", but newly emerging **explainability methods** are allowing the decisions made by DL models to be better interpreted.

Methods

We trained a **convolutional neural network** to classify 138 PD and 60 control brain MRI images acquired from the Parkinson's Progression Marker Initiative (PPMI) database.

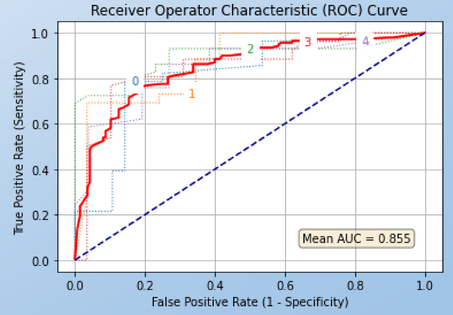
Models were assessed using 5-fold **cross-validation**.

We used **Deep SHapley Additive exPlanations** (DeepSHAP) to calculate and visualise the contribution of individual pixels to the model's prediction.

Results

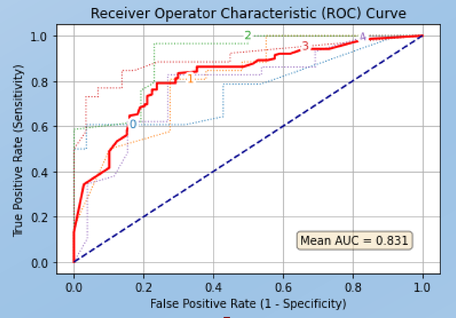
A model developed using a **combined dataset of axial T2 and proton density** MRI scans classified images with **79% accuracy** and a Receiver Operating Characteristic area under the curve (AUC) of 0.86.

❶



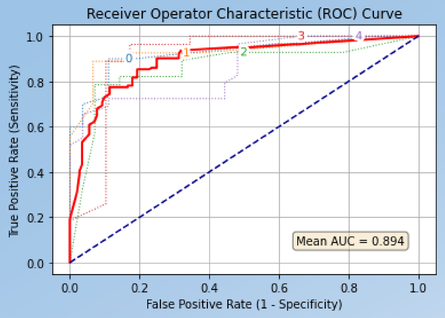
A model trained on just **T2** scans classified images with **81% accuracy** and 0.83 AUC.

❷



A model trained on just **proton density** scans classified images with **84% accuracy** and 0.89 AUC.

❸



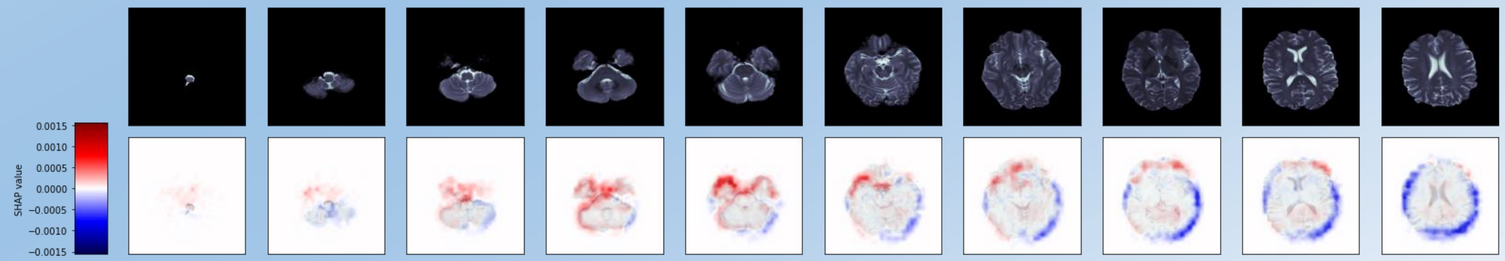
Average T2 axial DeepSHAP maps:

The heatmaps generated using Shapley values demonstrated predominant contribution to the prediction in the **midbrain slices**:

❶ PD prediction

Red: pixels that contribute to the model's prediction of PD

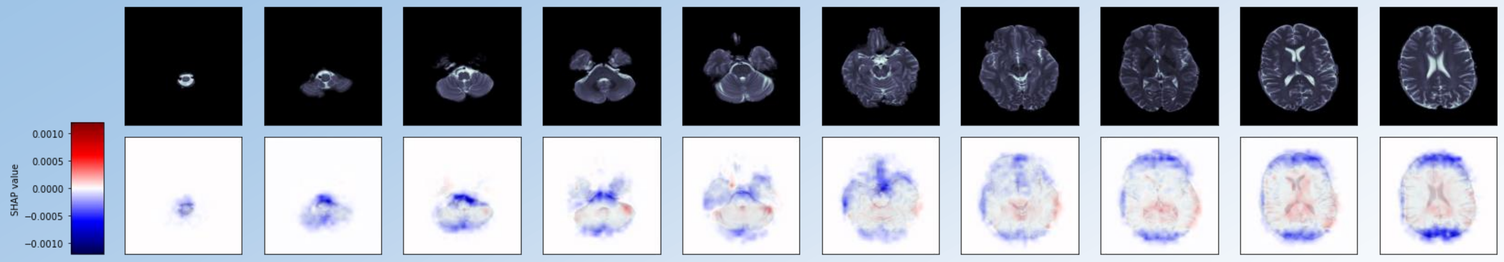
Blue: pixels that contribute to the model's prediction of Control



❷ Control prediction

Red: pixels that contribute to the model's prediction of PD

Blue: pixels that contribute to the model's prediction of Control



Conclusion

Our models exhibited **good diagnostic performance**. The use of explainable AI highlighted regions of interest **consistent with the known neuropathology of PD**, providing a focus for future work.

We will validate these models in a large dataset of **routinely collected NHS MRI scans**, many of which precede onset of motor symptoms.

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