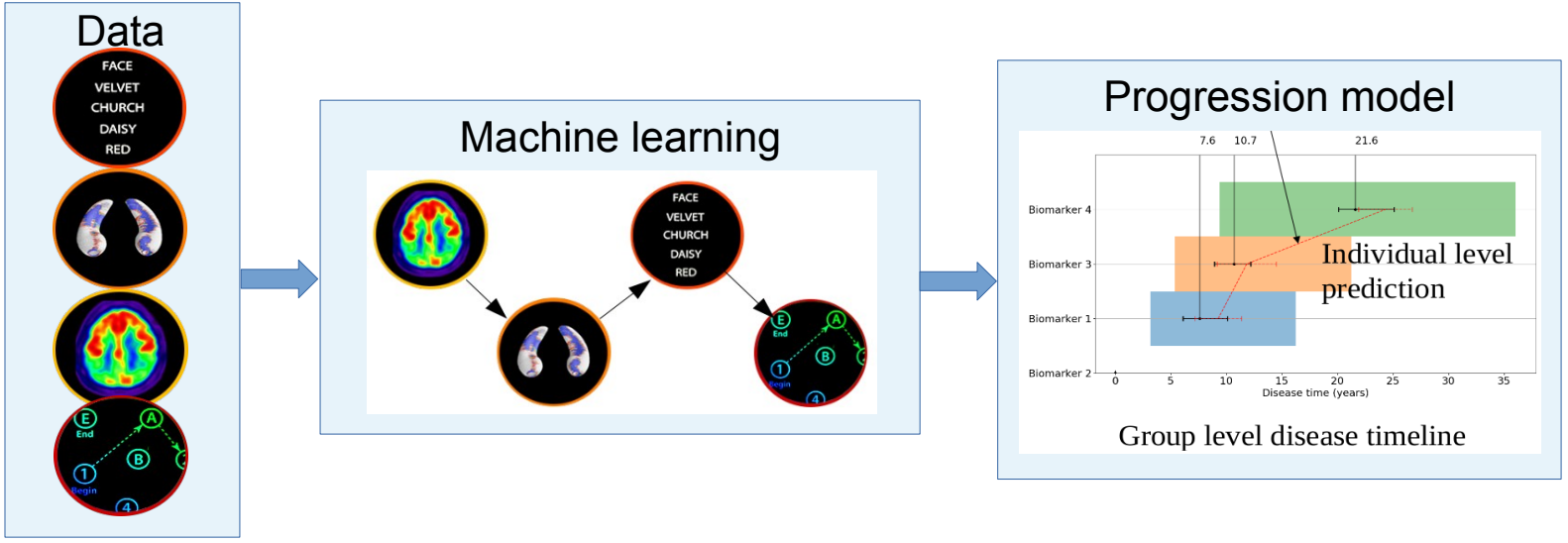
Learning timelines of dementia progression using machine learning and multi-modal data

BSMS Dementia Research Symposium
15/03/24

Peter Wijeratne



Our research: bridging computer and life sciences

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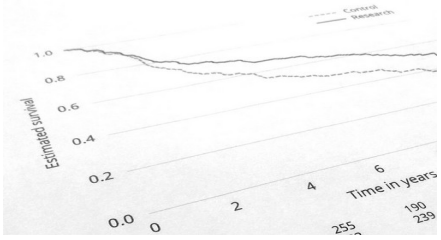
Informatics



Statistical & machine learning methods

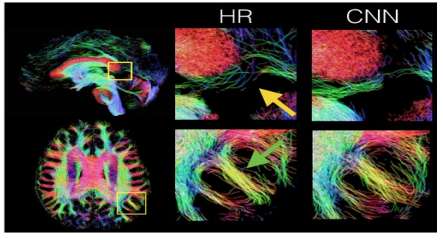
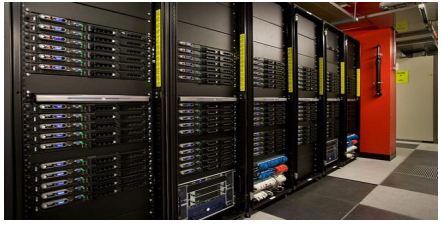


Image processing



High performance computing

Sussex AI Centre

Life sciences

sussex NEUROSCIENCE
open neuroscience

Neuroscience

Clinical imaging sciences

brighton and sussex medical school

Clinical and translational research

The big idea: ML in neuro-degeneration and development

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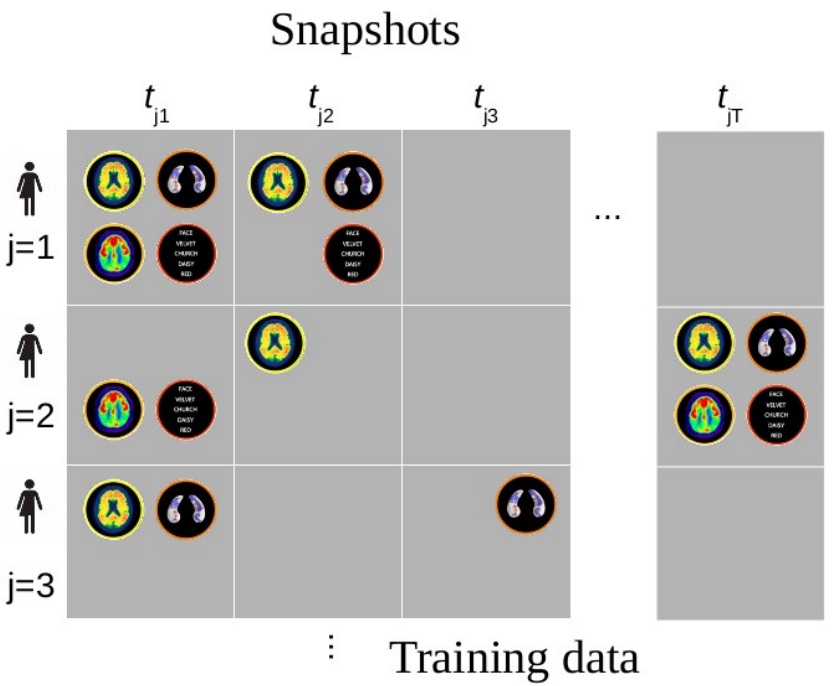
Build ML algorithms that can leverage multi-modal data to characterise and predict progression



The big idea: ML in neuro-degeneration and development

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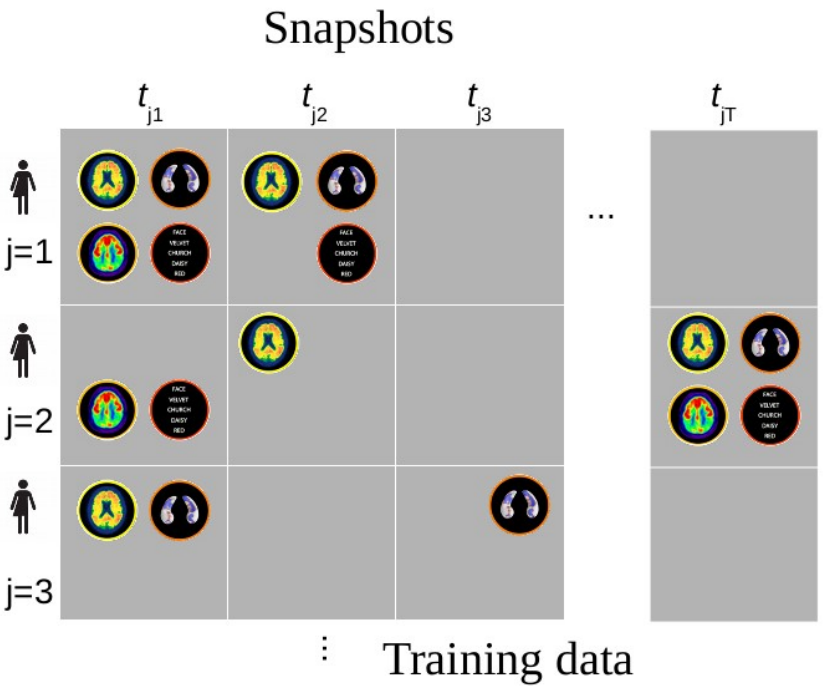

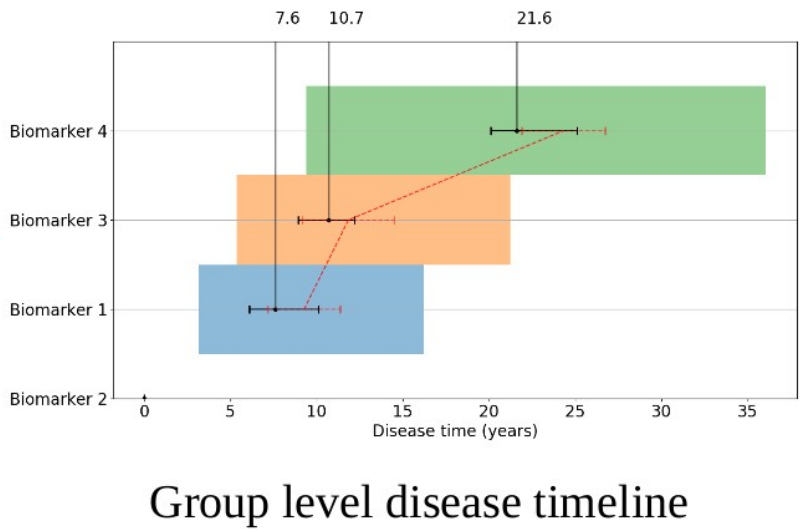

The big idea: ML in neuro-degeneration and development

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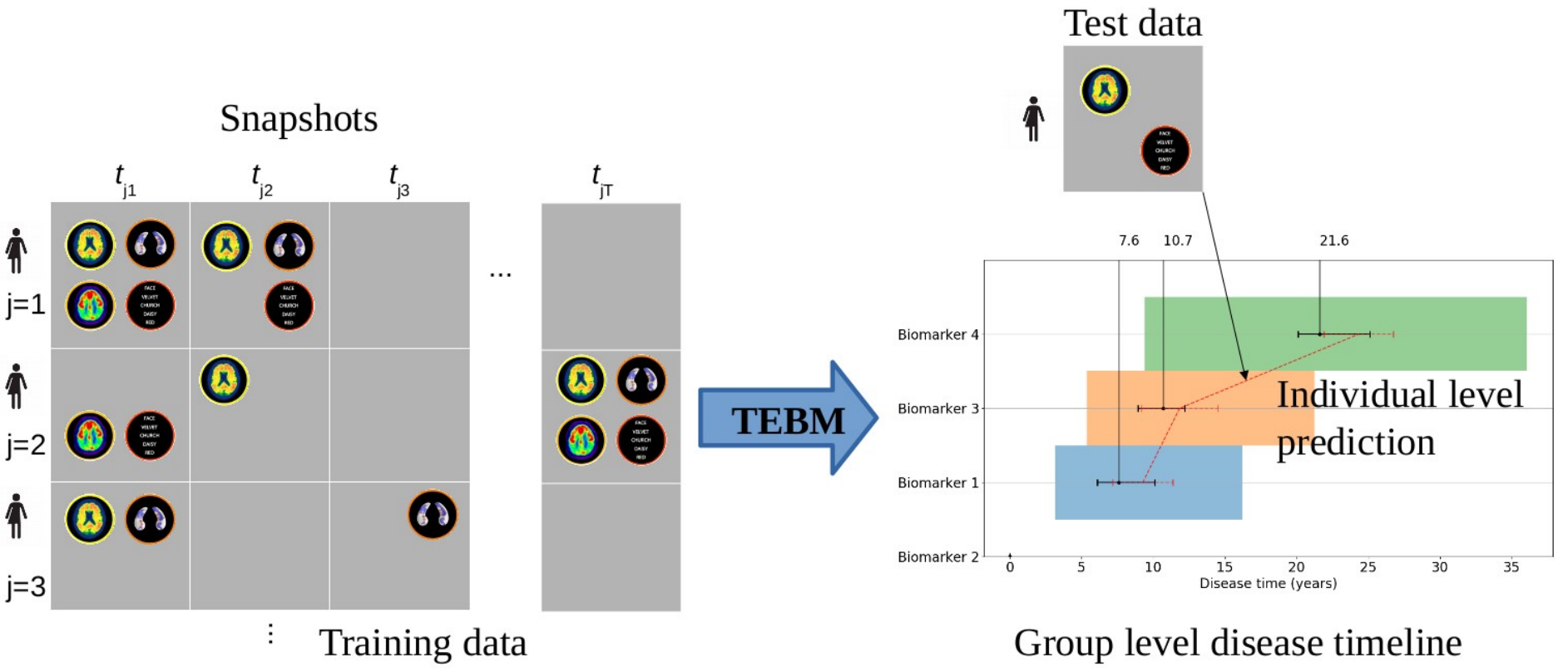


Types of data

Here we focus on studies with neuroimaging data

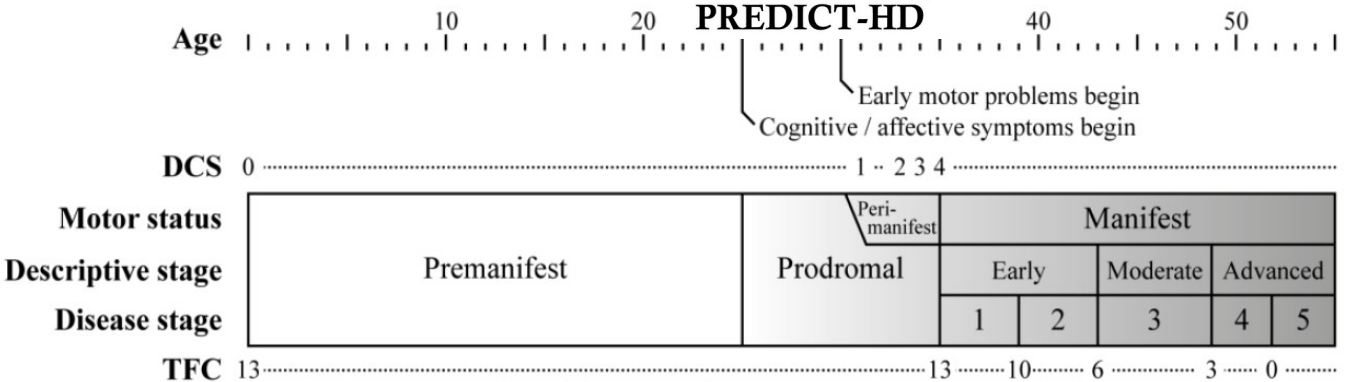
But methods can be applied to other data types, e.g., phenotypic, genetic, biofluid, ...

HD CSF

IMAGE-HD

TRACKHD

PREDICT-HD



Imaging and processing

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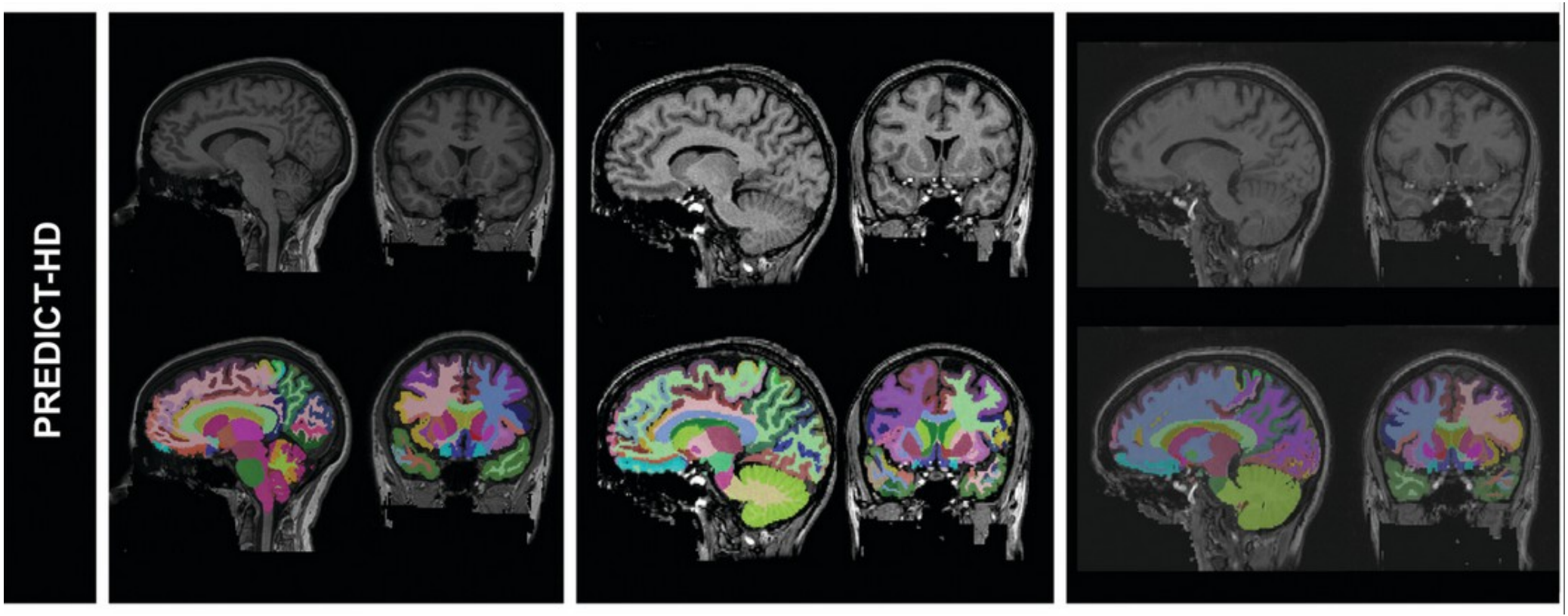


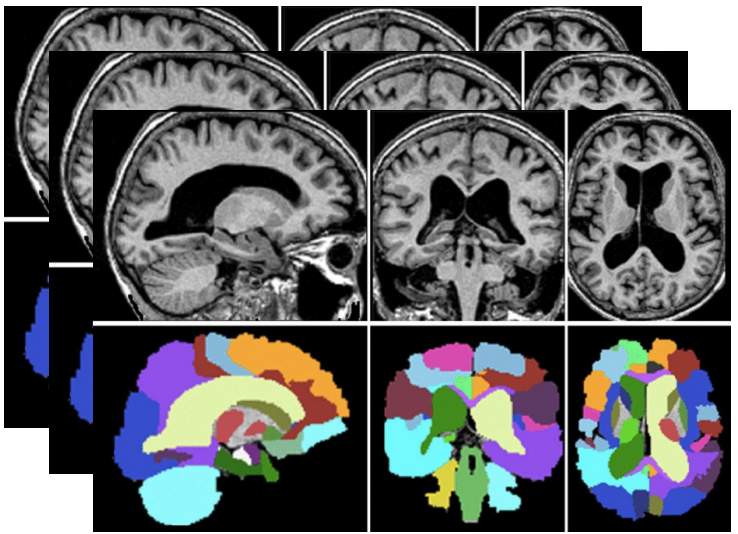
Extract regional brain volumes from structural MRI using automated segmentation tool + QC

Wijeratne & Johnson et al. Annals of Neurology. 2022

Research theme 1: modelling neurodegenerative patterns

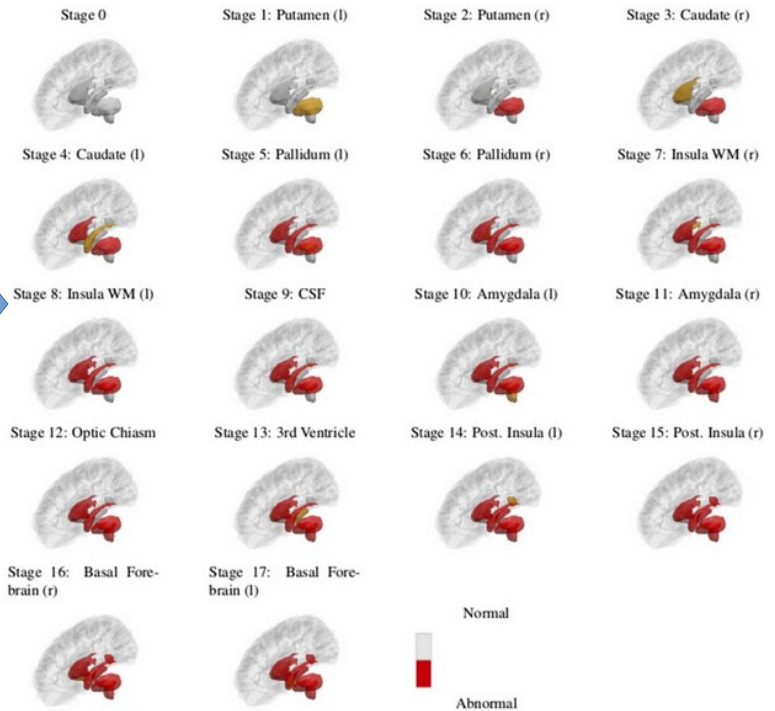
Use post-processed imaging data from a single time-point to learn ordering of regional brain volume changes across a population

Regional brain volumes



EBM

Order of regional brain atrophy in HD

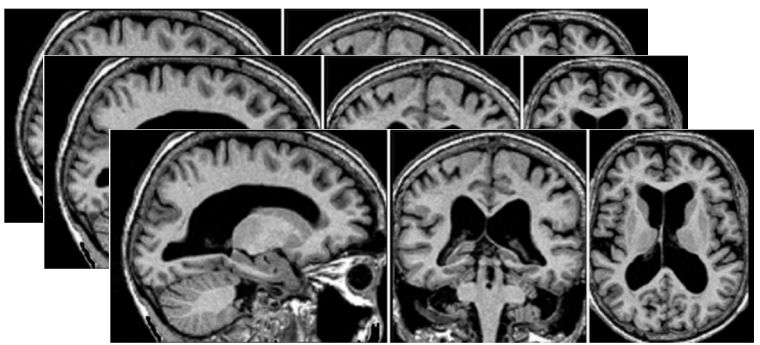


Wijeratne et al. Ann Clin Transl Neurol. 2018

Research theme 1: modelling neurodegenerative patterns

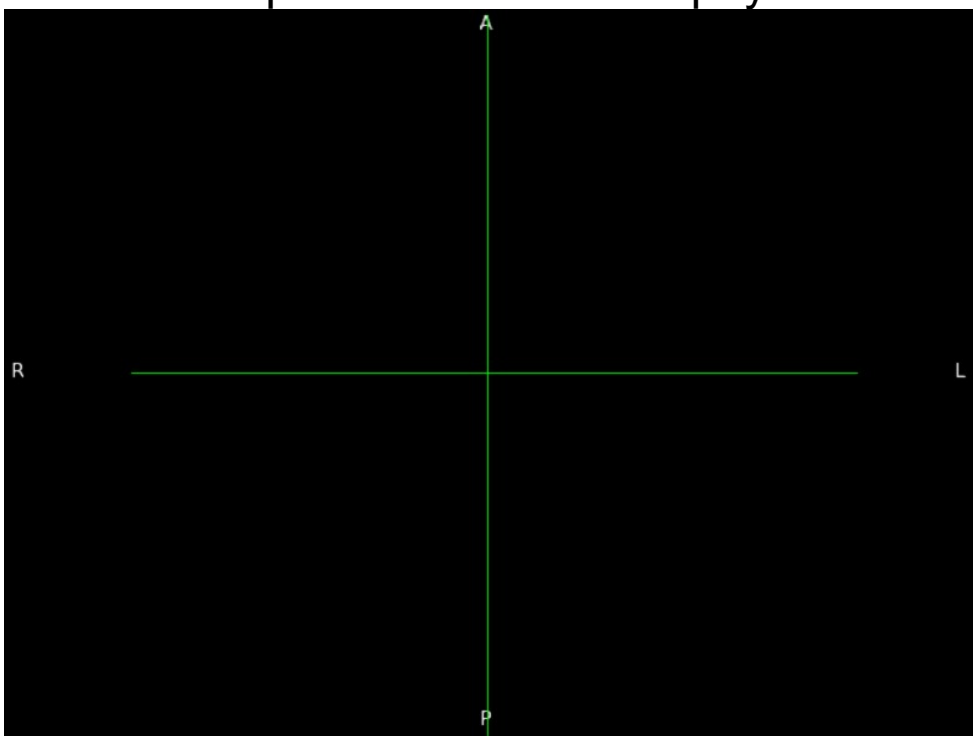
Use imaging data from a single time-point to learn ordering of pixel / voxel-wise changes across a population

Structural MRI



vEBM

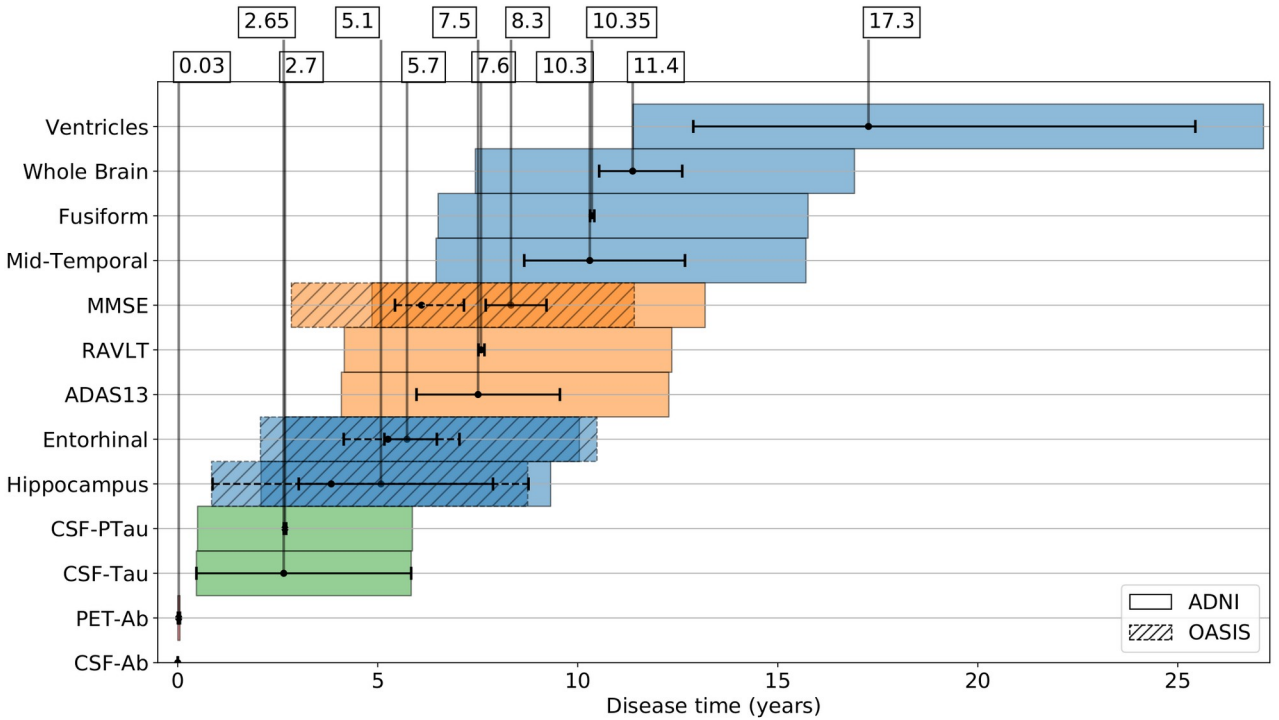
Order of pixel-wise brain atrophy in AD



In preparation

Research theme 2: modelling neurodegenerative timelines

Use multi-modal medical data (imaging, clinical, genetic, …) from multiple time-points to learn the ordering and timing of biomarker changes across a population



(a) Alzheimer's disease

Wijeratne et al. Imaging Neuroscience. 2023

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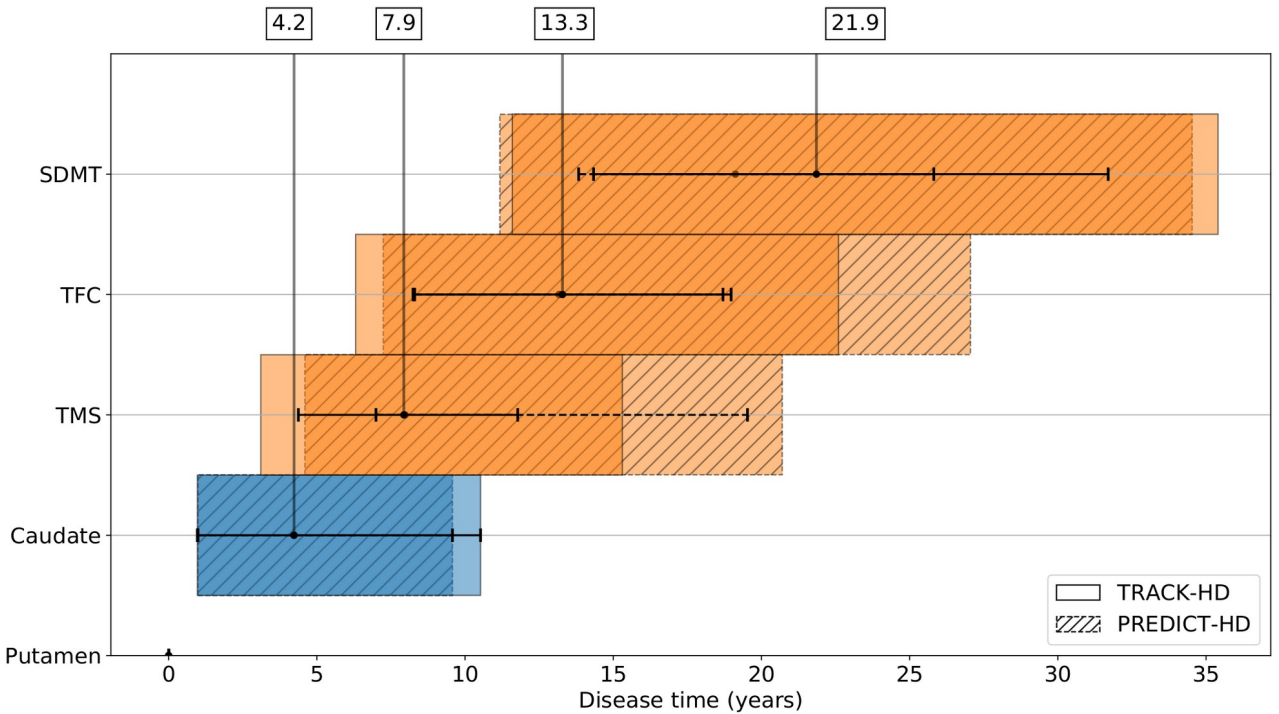
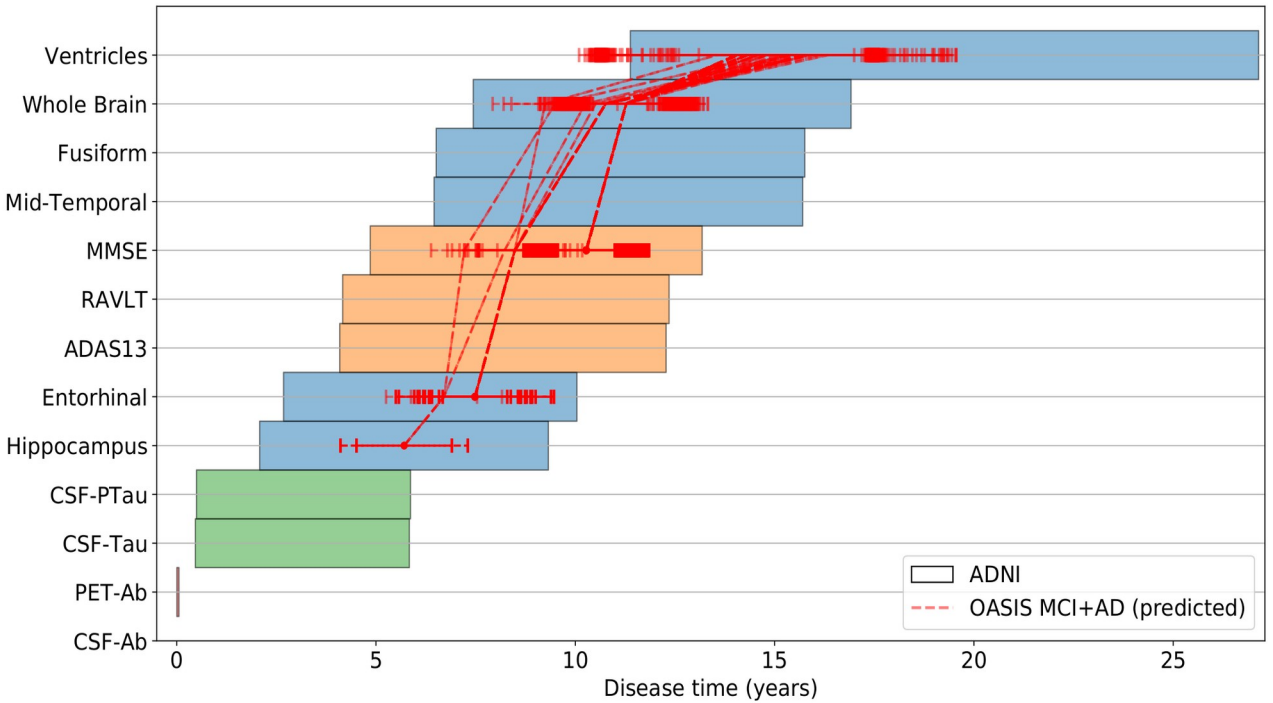


(b) Huntington's disease

Wijeratne et al. Imaging Neuroscience. 2023

Research theme 3: predicting individual progression

Use multi-modal medical data (imaging, clinical, genetic, …) from single or multiple time-points to predict progression



(a) Alzheimer's disease

Wijeratne et al. Imaging Neuroscience. 2023

Summary and next steps

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- ML is a useful tool that can leverage multi-modal data to both characterise and predict disease progression
- Our models have yielded new insights into AD and HD aetiology

- Next – predicting future trajectories at the individual level
  - Include individual covariates (genetics, risk factors…)
  - Inform on treatment planning, enrich clinical trials
- Next – other applications
  - Other progressive diseases (lung, eye, ...)
  - Neurodevelopment
  - ...