Brain Age Prediction Models

Diego Rodrigues

October 11, 2024

Outline

Common Prediction Models

- **Machine Learning Approaches:**
  - Support Vector Machines (SVM)
  - Random Forests
  - Neural Networks
- **Deep Learning Approaches:**
  - Convolutional Neural Networks (CNN)
  - Recurrent Neural Networks (RNN)
- **Feature Selection**
  - MRI-derived features
  - Cognitive and behavioral data

Challenges in Brain Age Prediction

- **Data Heterogeneity:** Variability in datasets and imaging protocols.
- **Model Generalizability:** Overfitting and applicability to different populations.
- **Interpretability:** Understanding what drives the predictions.

The Dallas Lifespan Brain Study

Overview of the DLBS[1]

- **Longitudinal multi-modal neuroimaging study initiated in 2008.**
- **Participants:** Ages 20-90, returning for three waves over approximately 10 years.
- **Data Collected:**
  - Structural MRI, diffusion MRI, functional MRI.
  - Amyloid and tau PET imaging.
  - Comprehensive cognitive and psychosocial assessments.
- **Aim:** Investigate MRI metrics related to brain aging and Alzheimer's disease biomarkers across the adult lifespan.

DLBS Data Acquisition

- **Cognitive Measures:**
  - Speed of Processing, Working Memory, Episodic Memory, Reasoning, Vocabulary, Verbal Fluency.
- **Surveys:**
  - Physical Health, Mental Health, Psychosocial Factors.
- **MRI Protocol:**
  - Functional tasks (Ventral Visual Task, Words Task, Scenes Task).
  - Structural imaging (MPRAGE, FLAIR).
  - Resting-state imaging, Diffusion Tensor Imaging (DTI), Arterial Spin Labeling (ASL).
- **PET Imaging:**
  - Amyloid PET using 18F-AV-45 (florbetapir).
  - Tau PET using 18F-AV-1451 (flortaucipir).

Data Analysis using DLBS

Participant Demographics

- **Age Range:** 20-90 years old.
- **Participants:** around 500 individuals at Wave 1 and 200 at Wave 3
- **Inclusion Criteria:** Right-handed, fluent in English, etc.
- **Exclusion Criteria:** MMSE score below threshold, major psychiatric or neurological disorders, etc.

Age Distribution at Wave 1 MRI

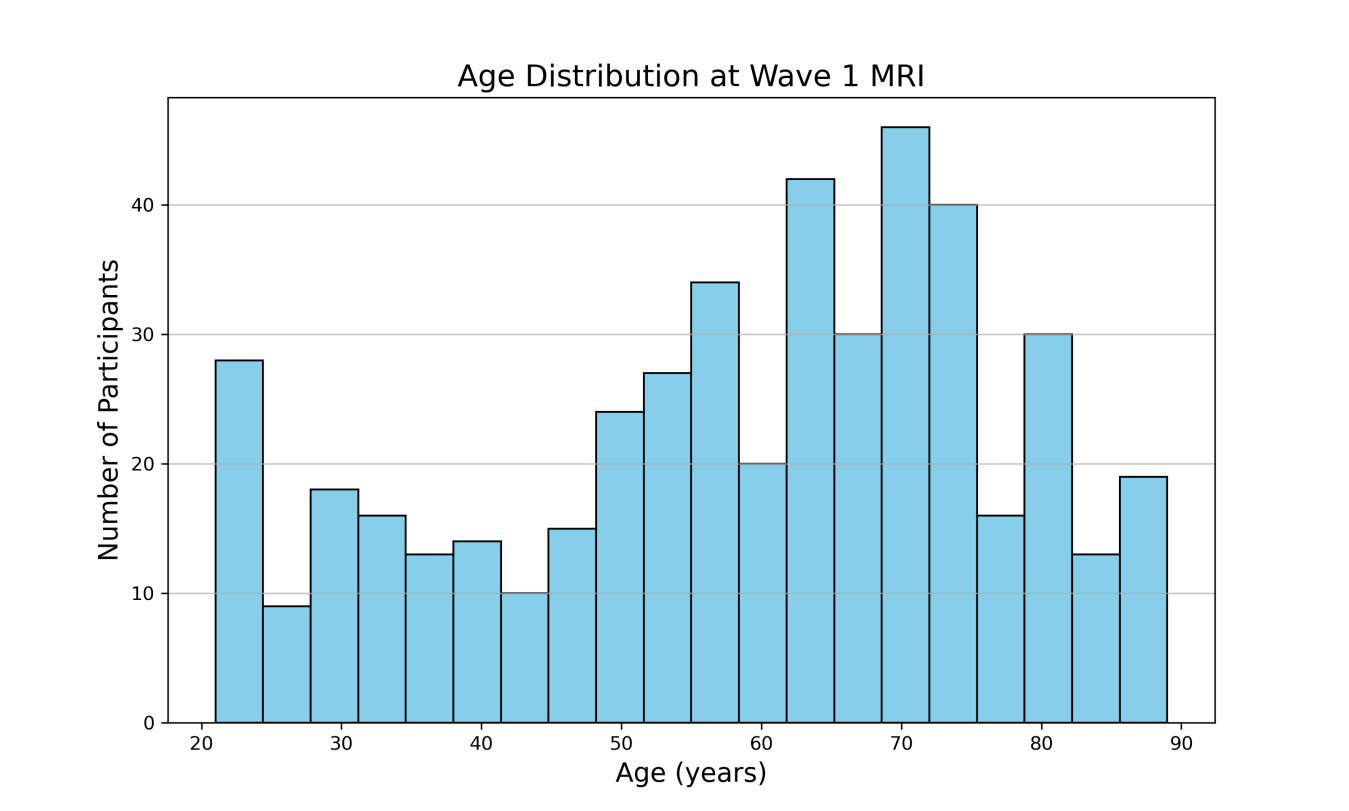

Figure 1: Histogram of participants' age at Wave 1 MRI

Sex Distribution of Participants

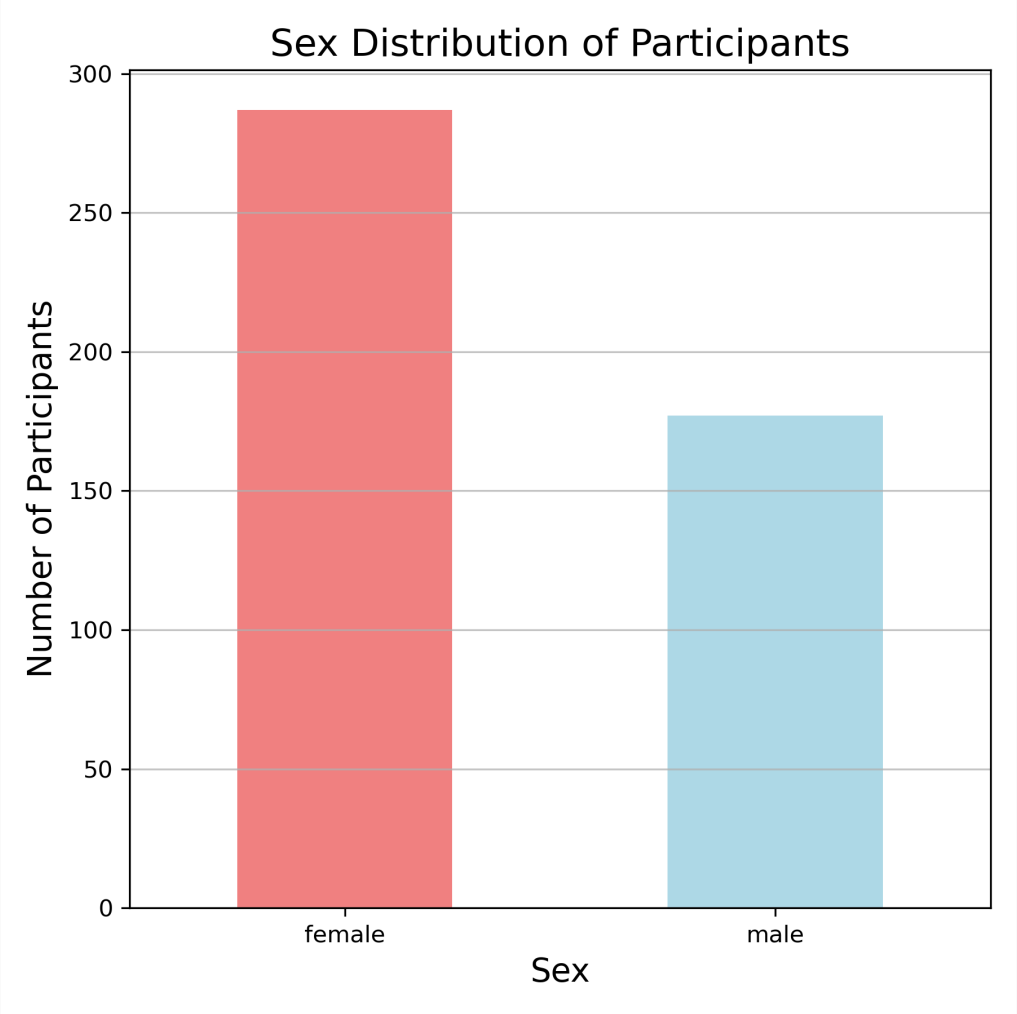

Figure 2: Bar chart of participants' sex distribution

Race Distribution of Participants

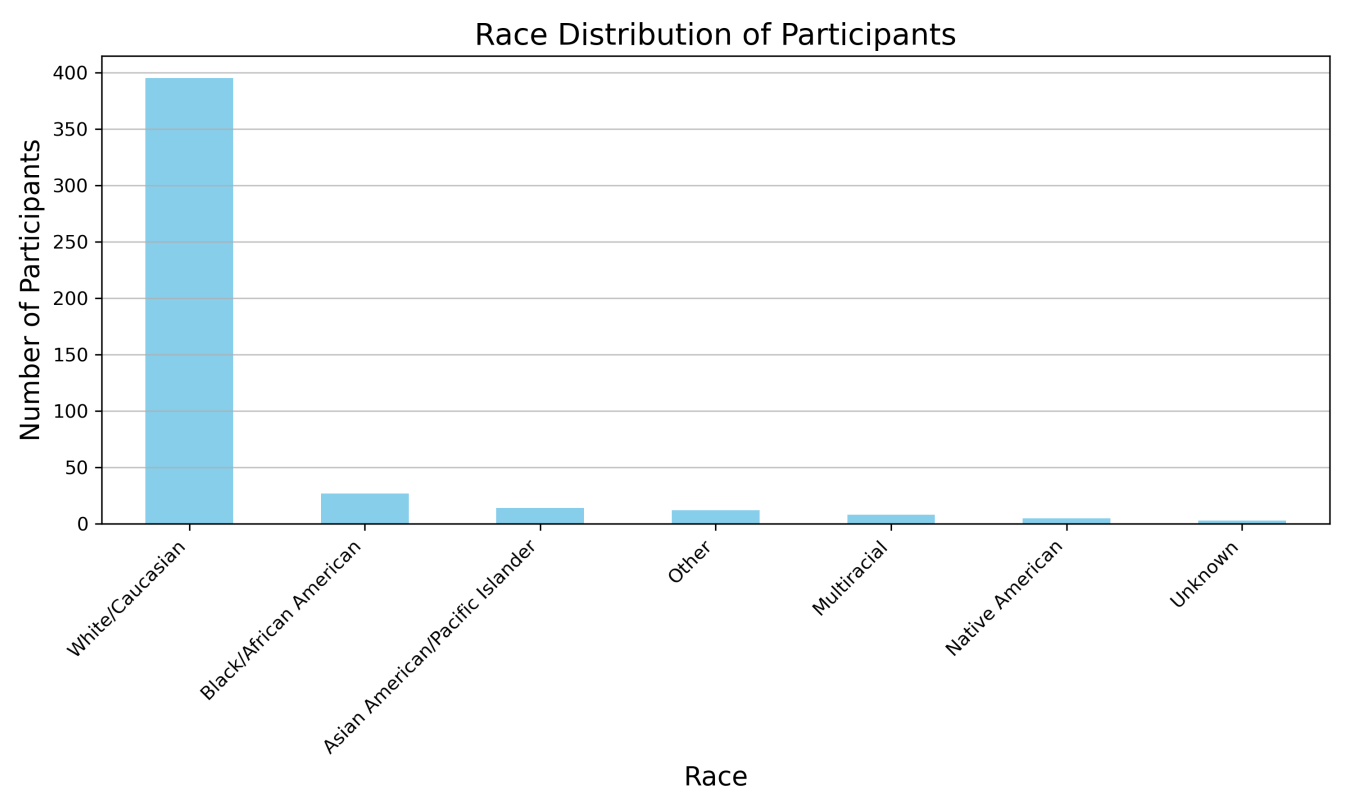

Figure 3: Bar chart of participants' race distribution

BMI Distribution at Wave 1

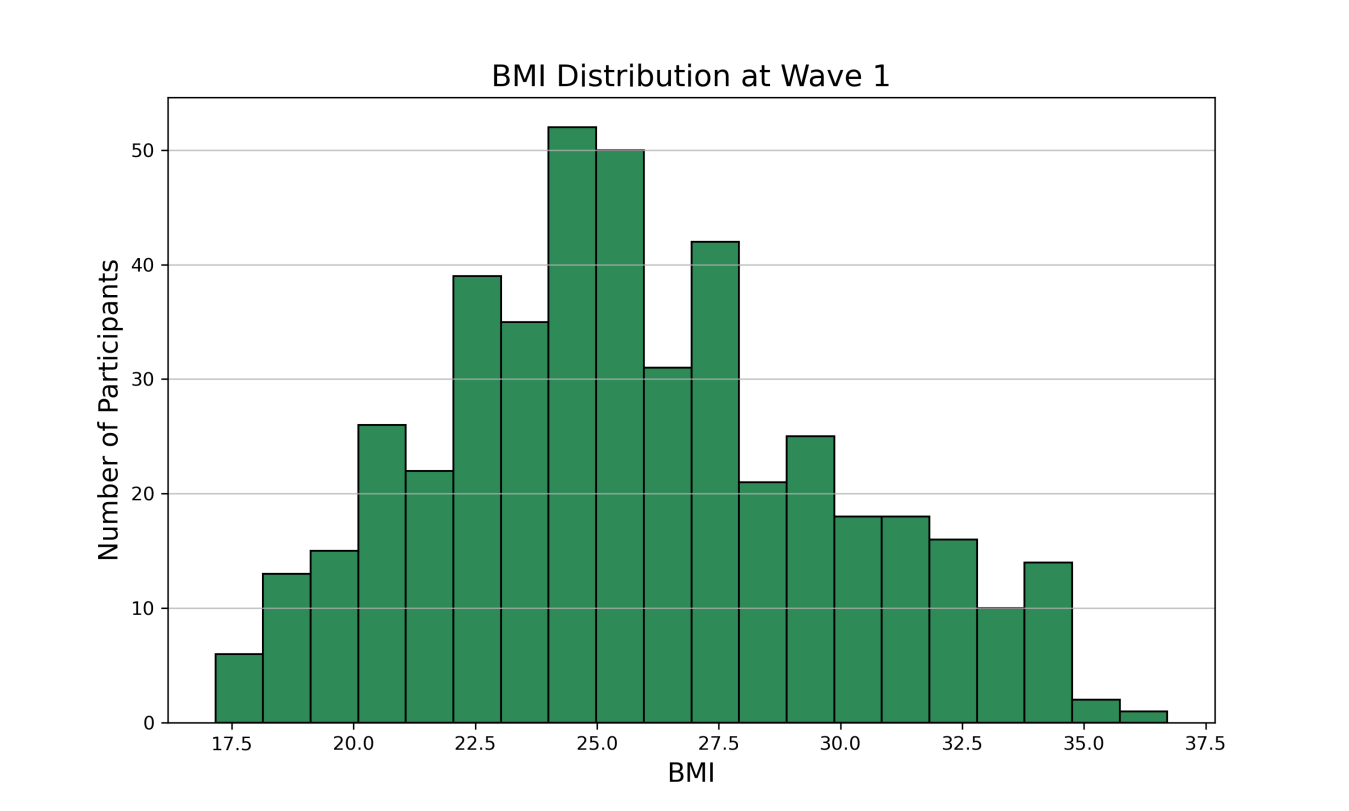

Figure 4: Histogram of BMI at Wave 1

Age vs. BMI at Wave 1

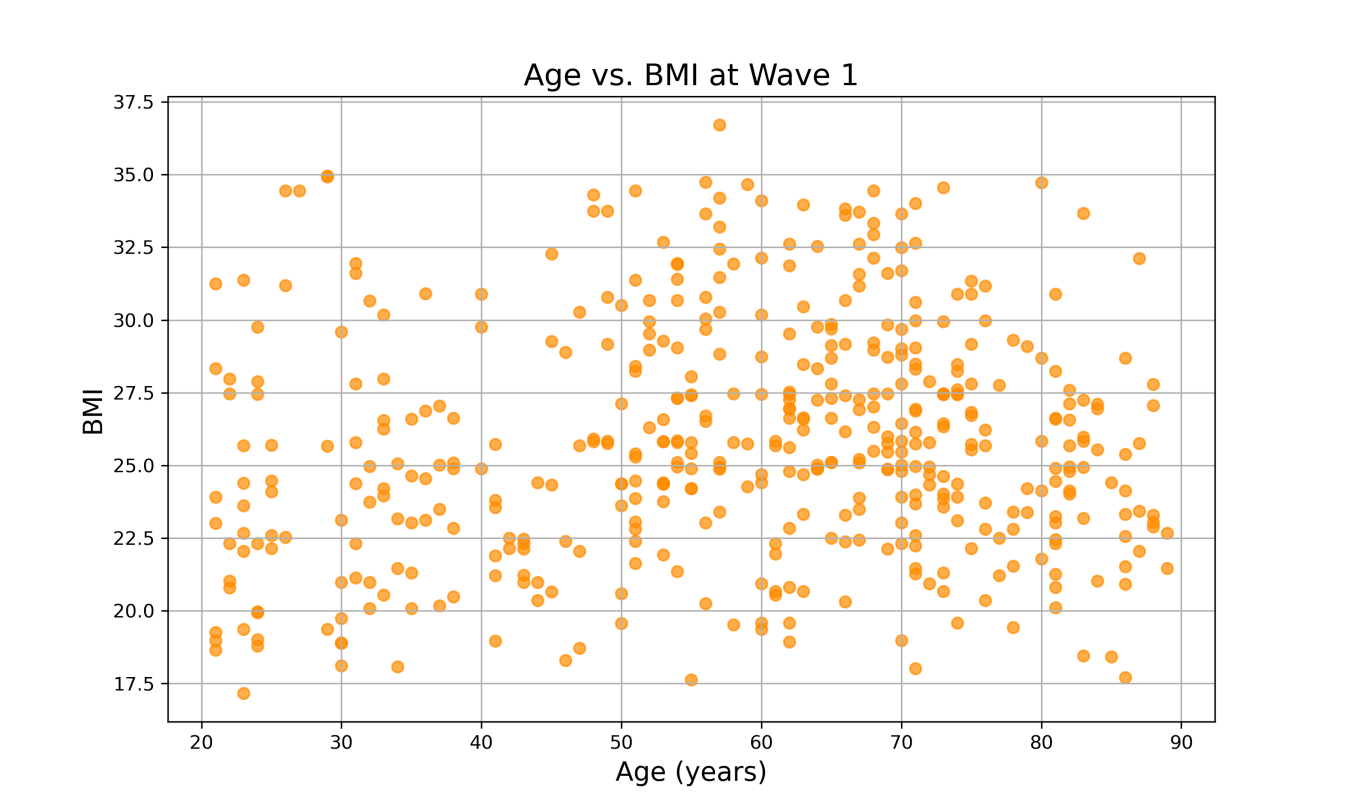

Figure 5: Scatter plot of Age vs. BMI at Wave 1

MMSE Score Distribution at Wave 1

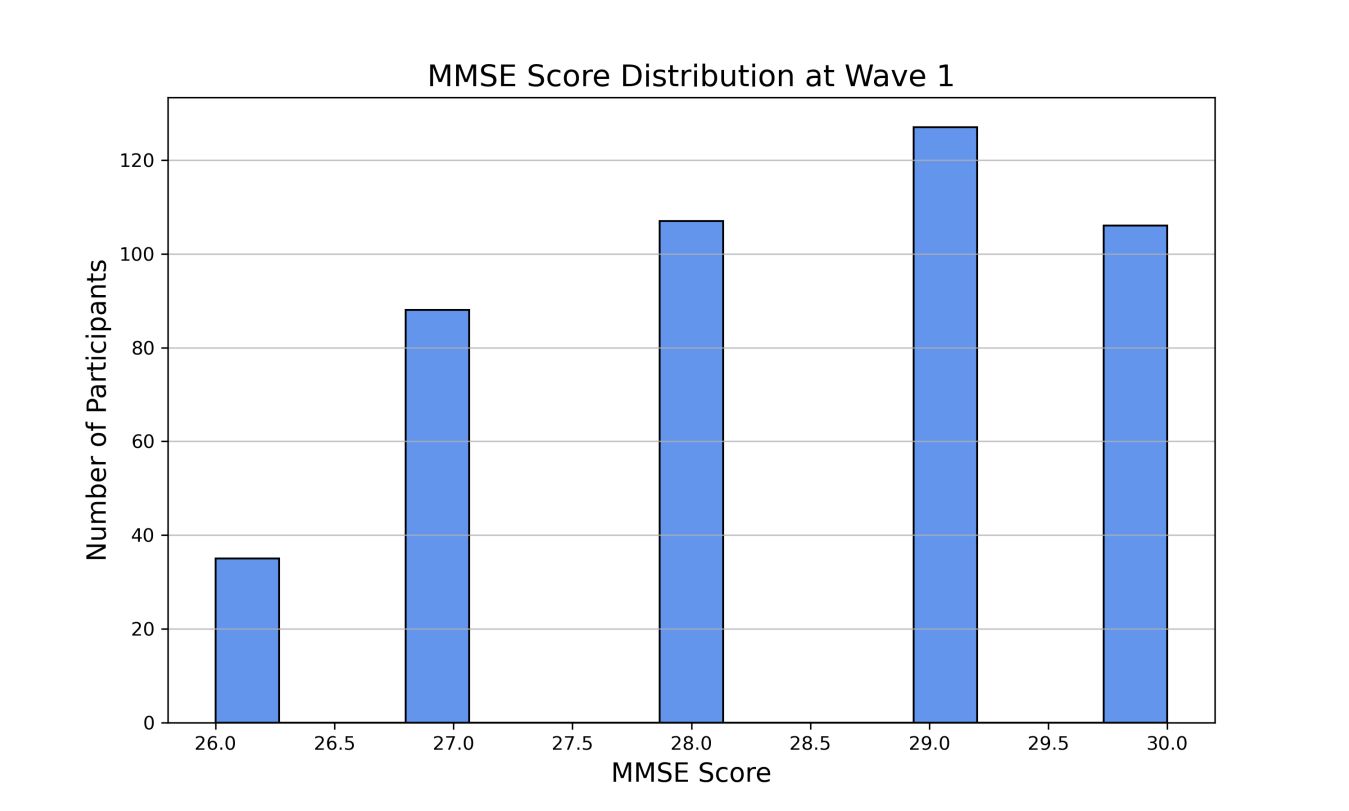

Figure 6: Histogram of MMSE scores at Wave 1

MMSE Score Distribution at Wave 2

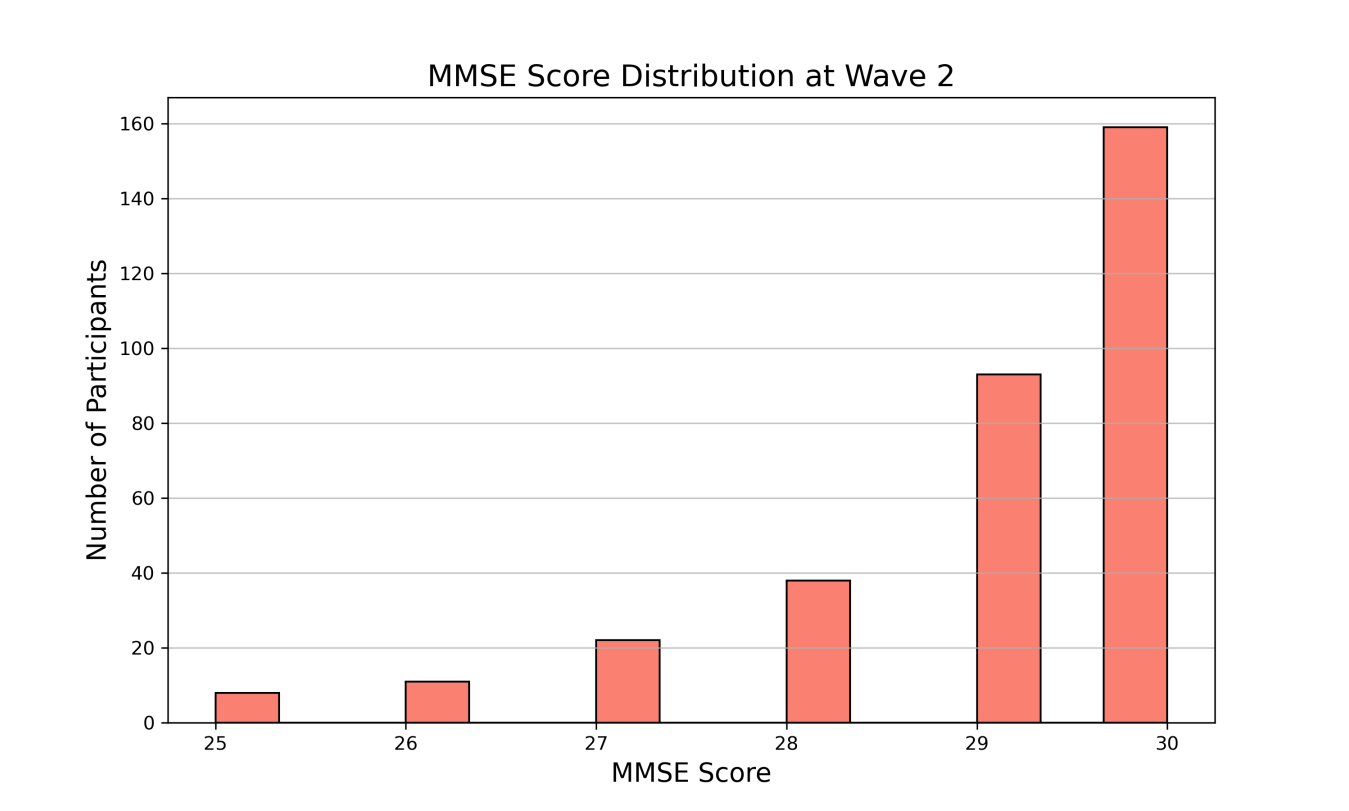

Figure 7: Histogram of MMSE scores at Wave 2

MMSE Score Distribution at Wave 3

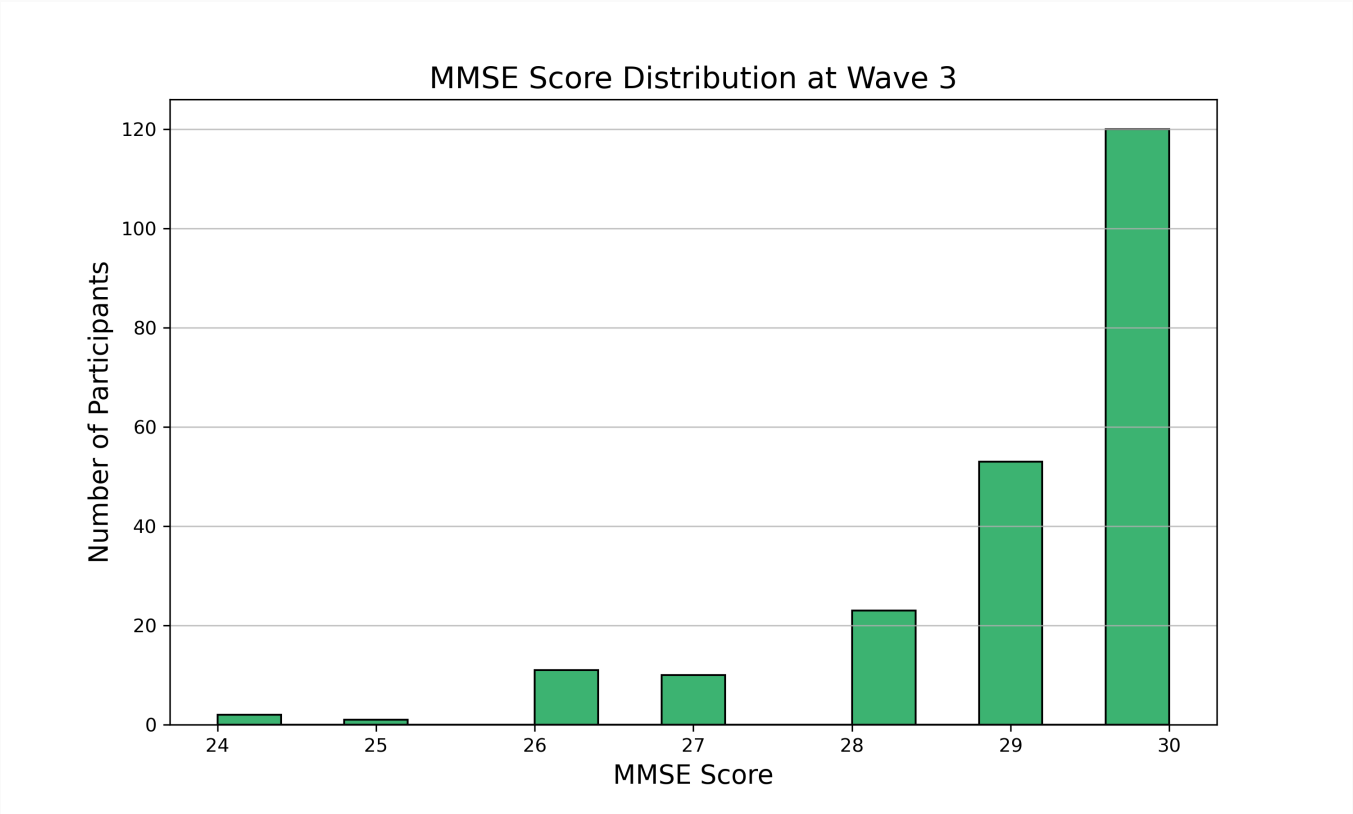

Figure 8: Histogram of MMSE scores at Wave 3

MRI Protocol in DLBS

- **Structural MRI:** MPRAGE, FLAIR.
- **Functional MRI Tasks:**
  - Ventral Visual Task
  - Words Task
  - Scenes Task
- **Resting-State Imaging**
- **Diffusion Tensor Imaging (DTI)**
- **Arterial Spin Labeling (ASL)**

Participants with MRI Data at Each Wave

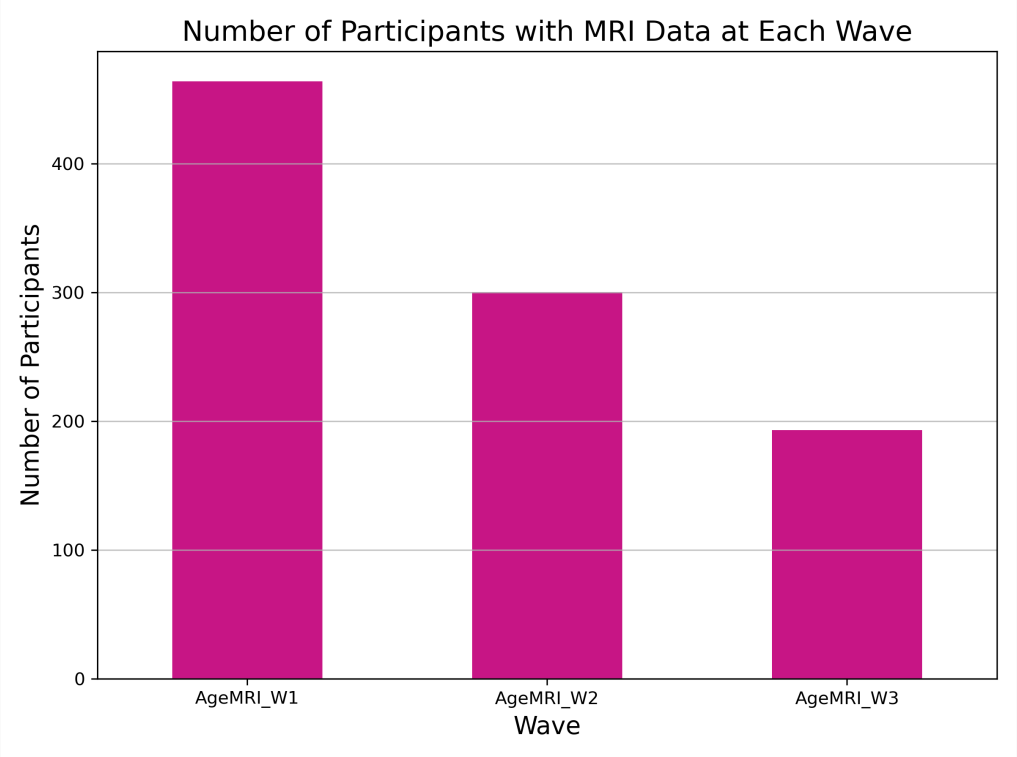

Figure 9: Number of participants with MRI data at each wave

Time Interval Between Wave 1 and Wave 2

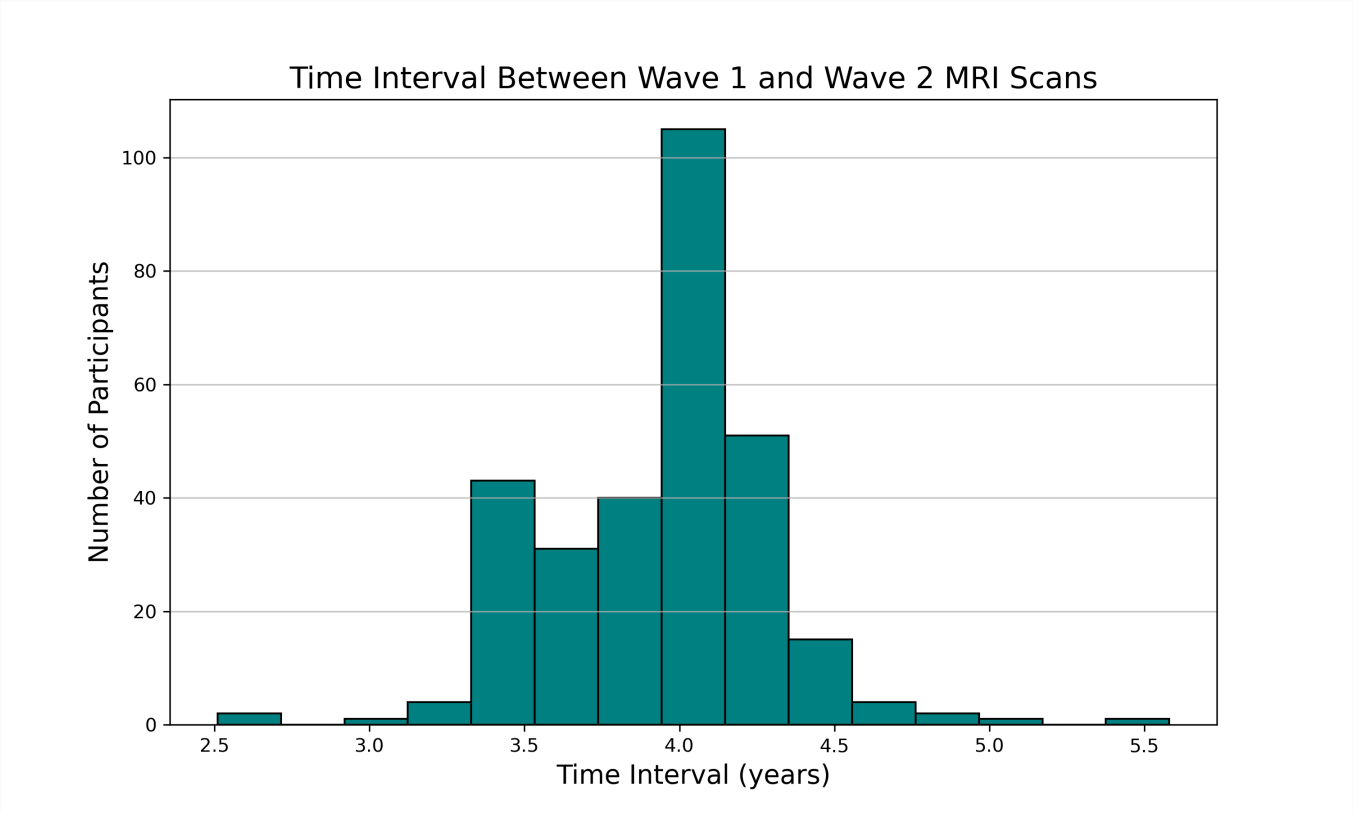

Figure 10: Time interval between Wave 1 and Wave 2 MRI scans

Time Interval Between Wave 2 and Wave 3

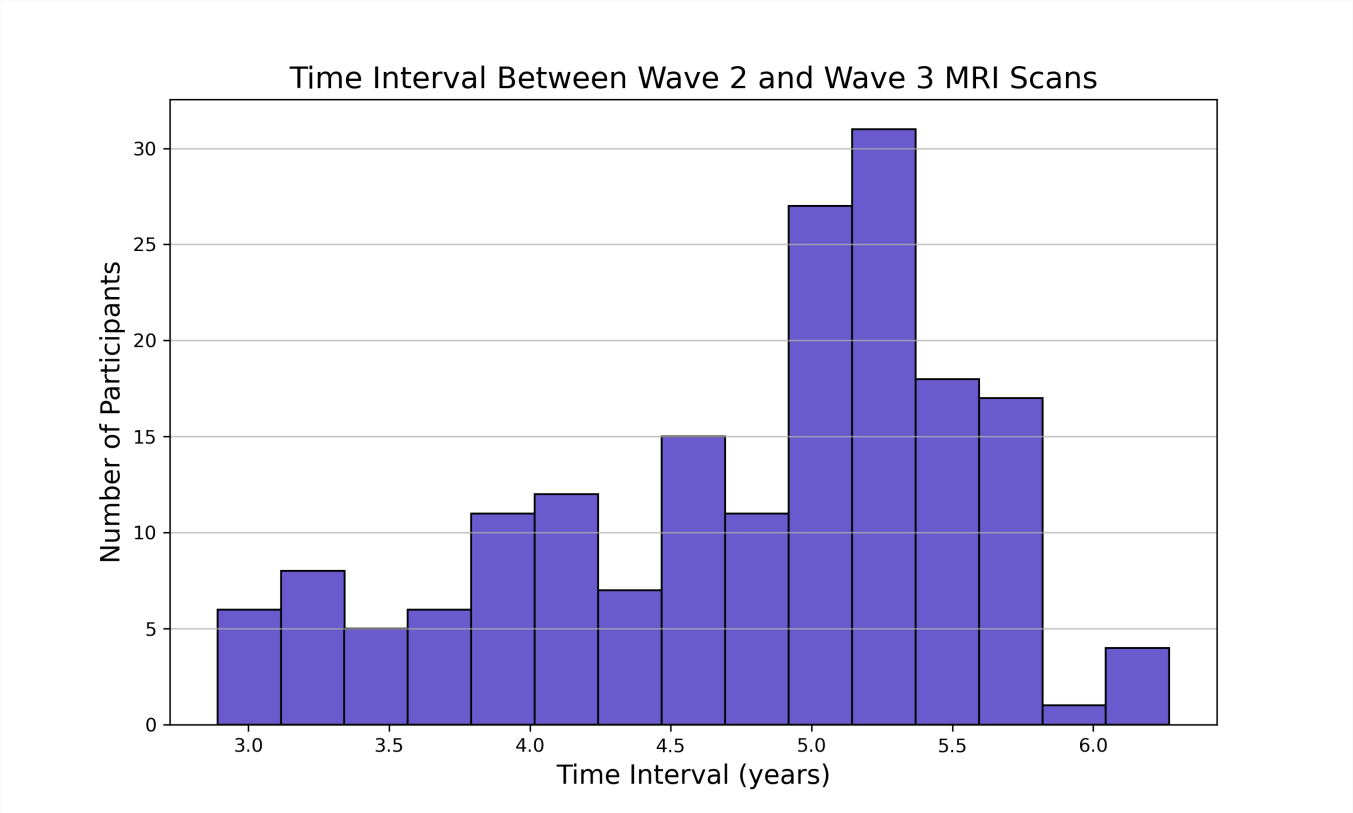

Figure 11: Time interval between Wave 2 and Wave 3 MRI scans

Correlation Matrix of Participants Data

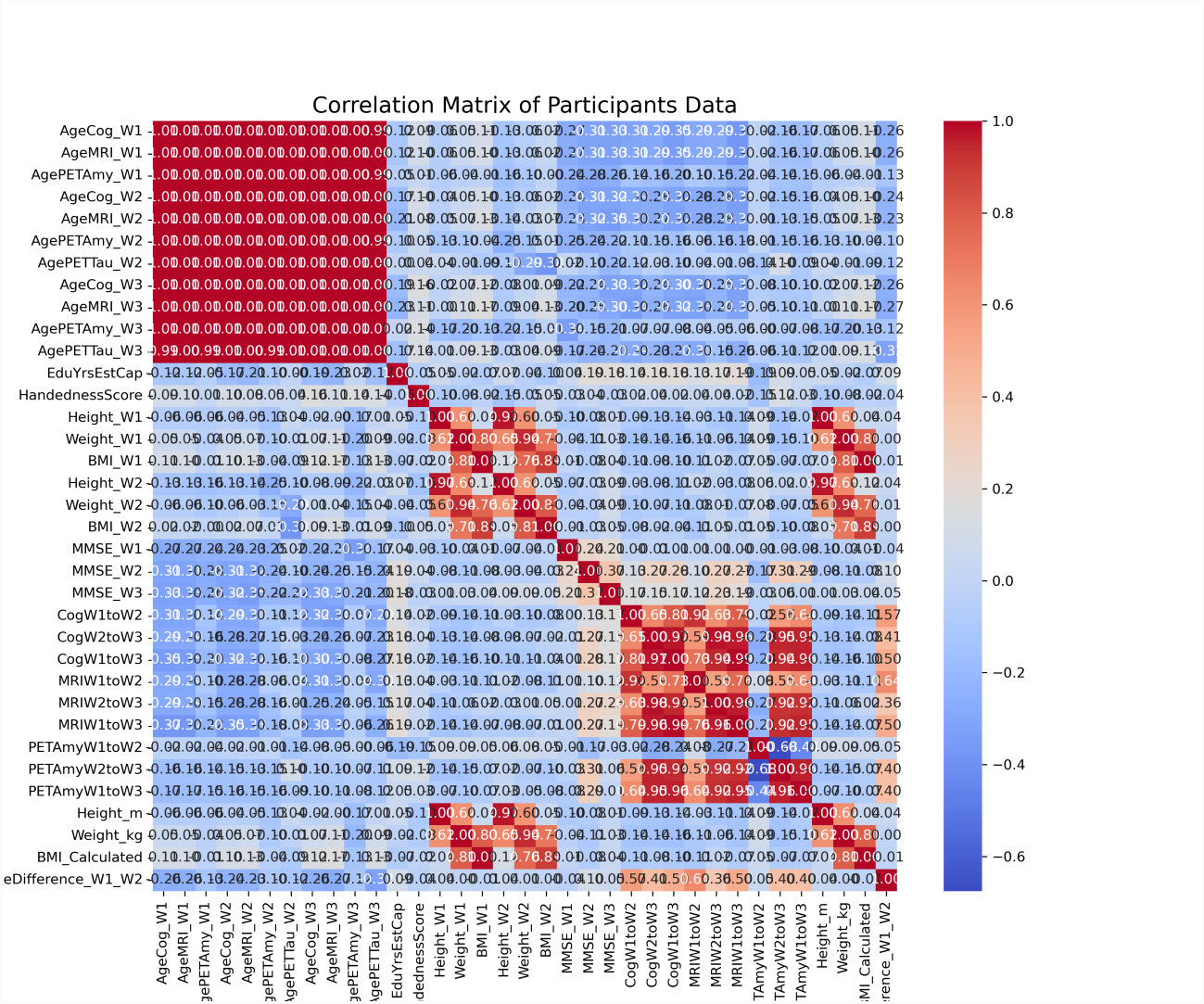

Figure 12: Heatmap of correlations among numerical variables

References

References i

Denise Park, Joseph Hennessee, Evan T. Smith, Micaela Chan, Carson Katen, Gagan Wig, Karan Rodrigue, and Kristen Kennedy.
The Dallas Lifespan Brain Study, 2024.