# Using Automatic HARDI Feature Selection, Registration, and Atlas Building to Characterize the Neuroanatomy of Aβ Pathology

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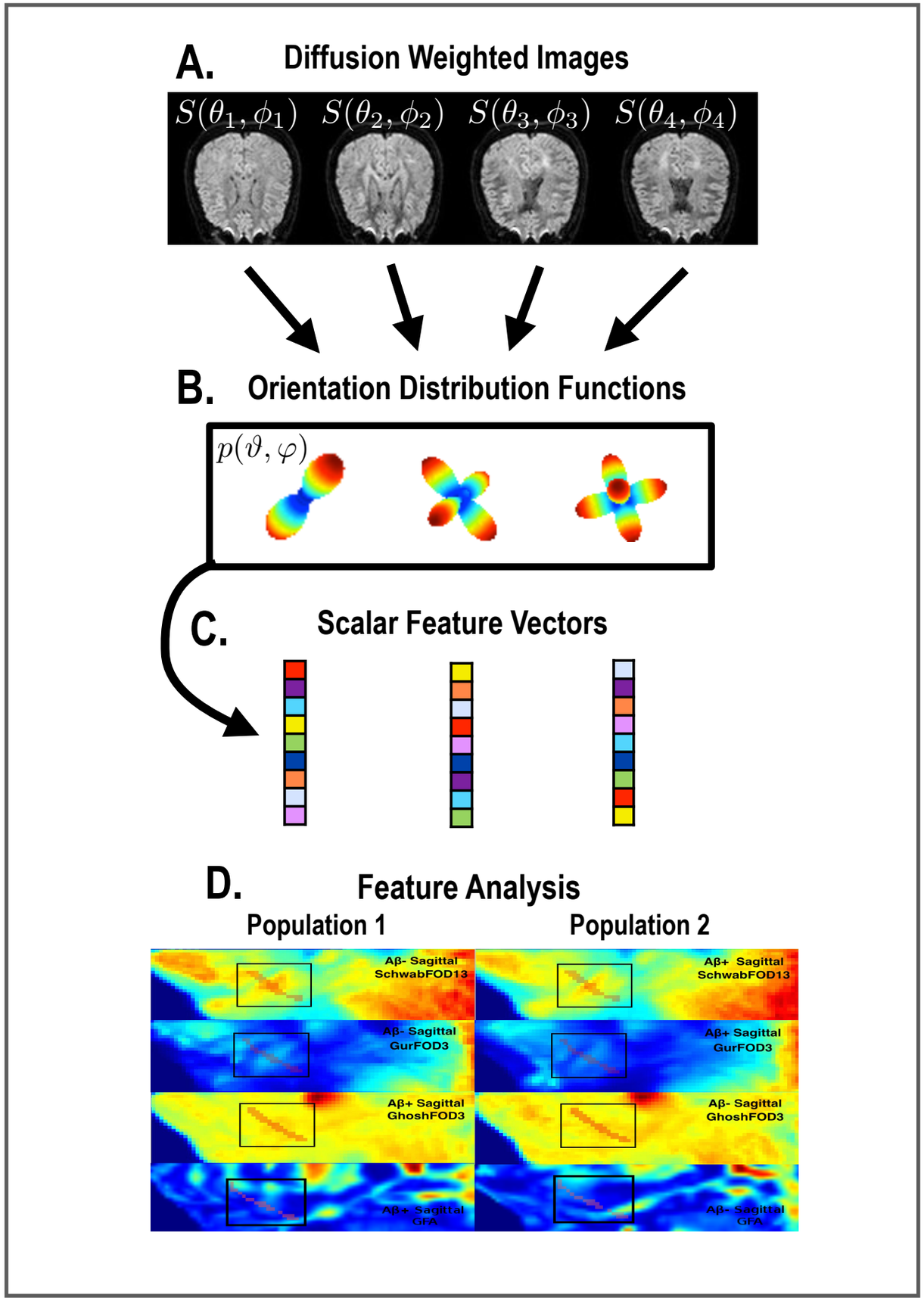
Power Pitch

# HARDI: From DWI to Feature Analysis

- **Goal:** Develop methods to automatically extract a set of interpretable and discriminative features from HARDI for disease classification.
- **Prior Work:** Register subject data to a common atlas, extract simple features in registered space, and use them to train a classifier.
- **Question 1:** At what stage (A, B, or C) should registration and atlas building be done to optimize feature analysis and processing?
- **Question 2:** How should the most biologically informative features be selected?
- **Idea:** Select features that are important for both registration, atlas construction and disease classification.



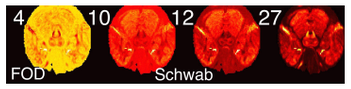
# Optimize Processing for Feature Analysis

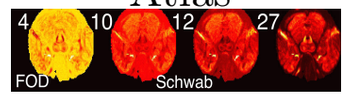
- **Solution:** An automatic method for joint HARDI feature selection, registration and atlas building.
- **Advantages:**
  - Automatically selects anatomically informative features driven by registration and not disease specific.
  - Preserves and optimizes feature data throughout processing.
  - Registers HARDI while bypassing the need for re-orientation and re-estimation of diffusion data.
  - Generalizes to features extracted using any dMRI acquisition, signal reconstruction and diffusivity profile estimation methods.
  - Constructs novel feature atlases.

$$\text{Start}: \{W_c^{(0)}\} = 1, \text{Atlas}^{(0)} = \text{Subject}_i, \text{ Features } c = \{4, 10, 12, 27\}$$

1. Register Subjects to Current Atlas with Current Weights

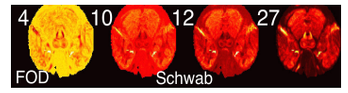
$$\text{mcLDDMM}\{W_c^{(k)}\} = \theta_i^{(k)}$$

$\text{Subject}_i$ 


$\text{Atlas}^{(k)}$ 


2. Take Average of Subjects in Atlas Space

$$\frac{1}{N}\sum_i \text{Subject}_i \circ \theta_i^{(k)} \rightarrow \text{Average}^{(k)}$$

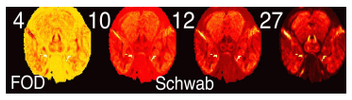


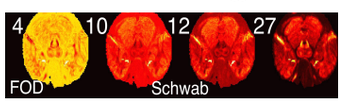

3. Calculate Error of Registration to Estimate New Weights

$$\frac{1}{N}\sum_i ||\text{Subject}_i \circ \theta_i^{(k)} - \text{Atlas}^{(k)}|| \rightarrow \{W_c^{(k+1)}\}$$

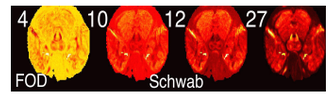
4. With Updated Weights and Average, Create New Atlas

$$\text{mcLDDMM}\{W_c^{(k+1)}\} = \mu^{(k+1)}$$

$\text{Atlas}^{(0)}$ 


$\text{Average}^{(k)}$ 


$$\text{Atlas}^{(0)} \circ \mu^{(k+1)} \rightarrow \text{Atlas}^{(k+1)}$$




$$\text{End}: \{W_c^{(K)}\}, \text{ Atlas}^{(K)}$$