

# *Morphologies Measurement*

## Protocol Notes

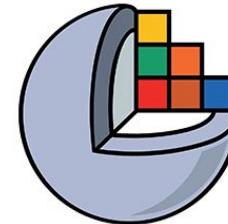
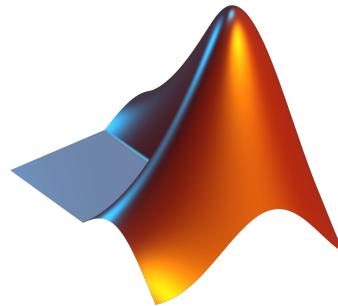
*O'Connell Biomechanics Lab*

Yousuf + Sylvi

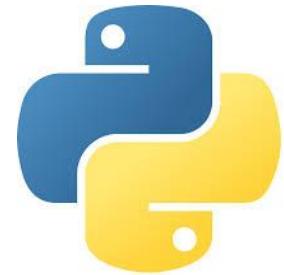
Winter 2025



Last updated: 1/29/2026



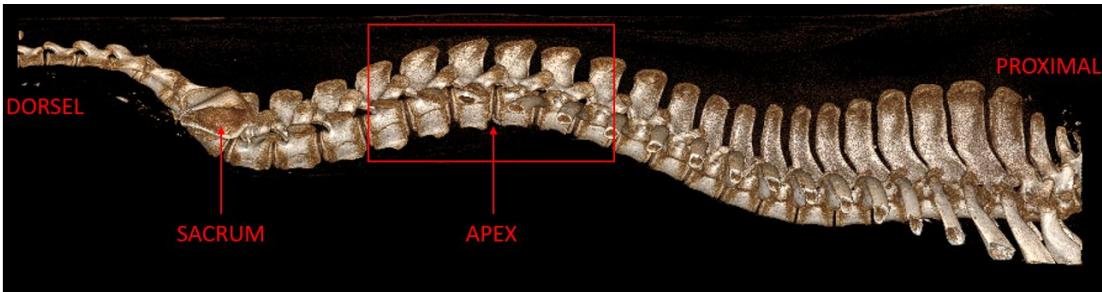
3D Slicer



Berkeley  
UNIVERSITY OF CALIFORNIA

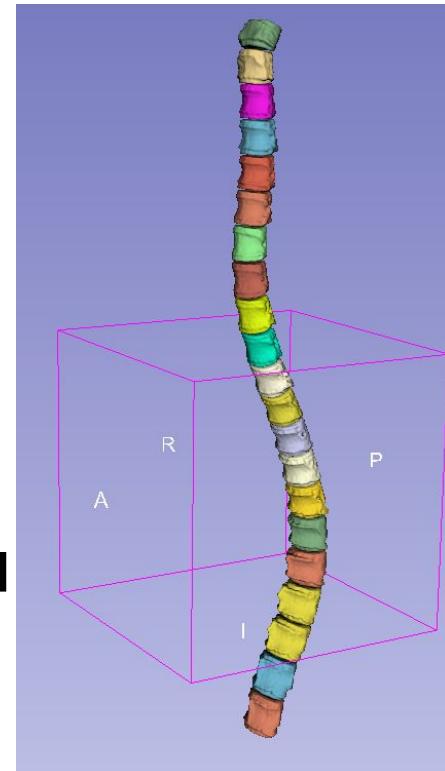
# Measurement Protocol Overview

Raw imaging data

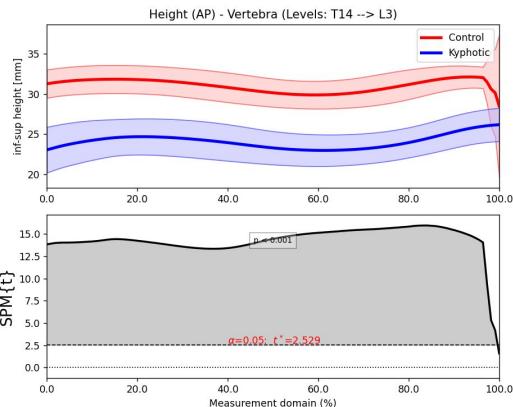


Full spine segmentation<sup>[1]</sup>

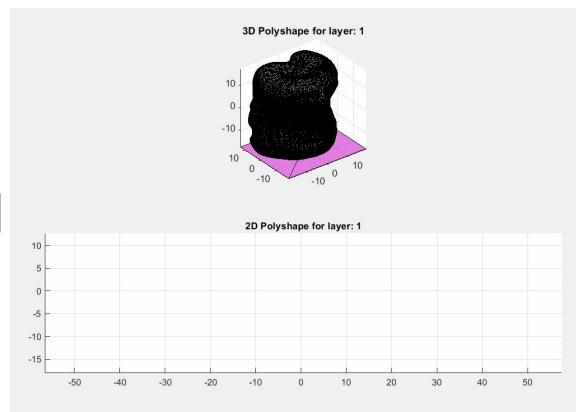
Assumes: 15  
thoracic + 6  
lumbar levels



Statistical Analysis



(Automated) MATLAB measurements



[1] Manual segmentation protocols [here](#)

# Programming Overview

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**Morphologies** Github [here](#)<sup>[1-2]</sup>, general pipeline:

*Loading all vertebrae geometry files → disc construction → geometry alignment →  
slicer, height, and volume measurements → analysis*

## Morphologies

**Author:** Yousuf Abubakr ([yousufabubakr123@berkeley.edu](mailto:yousufabubakr123@berkeley.edu))

**Lab:** Grace O'Connell Biomechanics Lab (<https://oconnell.berkeley.edu/>)

**Description:** A toolkit for processing, analyzing, and visualizing morphological data from medical imaging datasets (e.g., STL meshes, MATLAB measurement files).

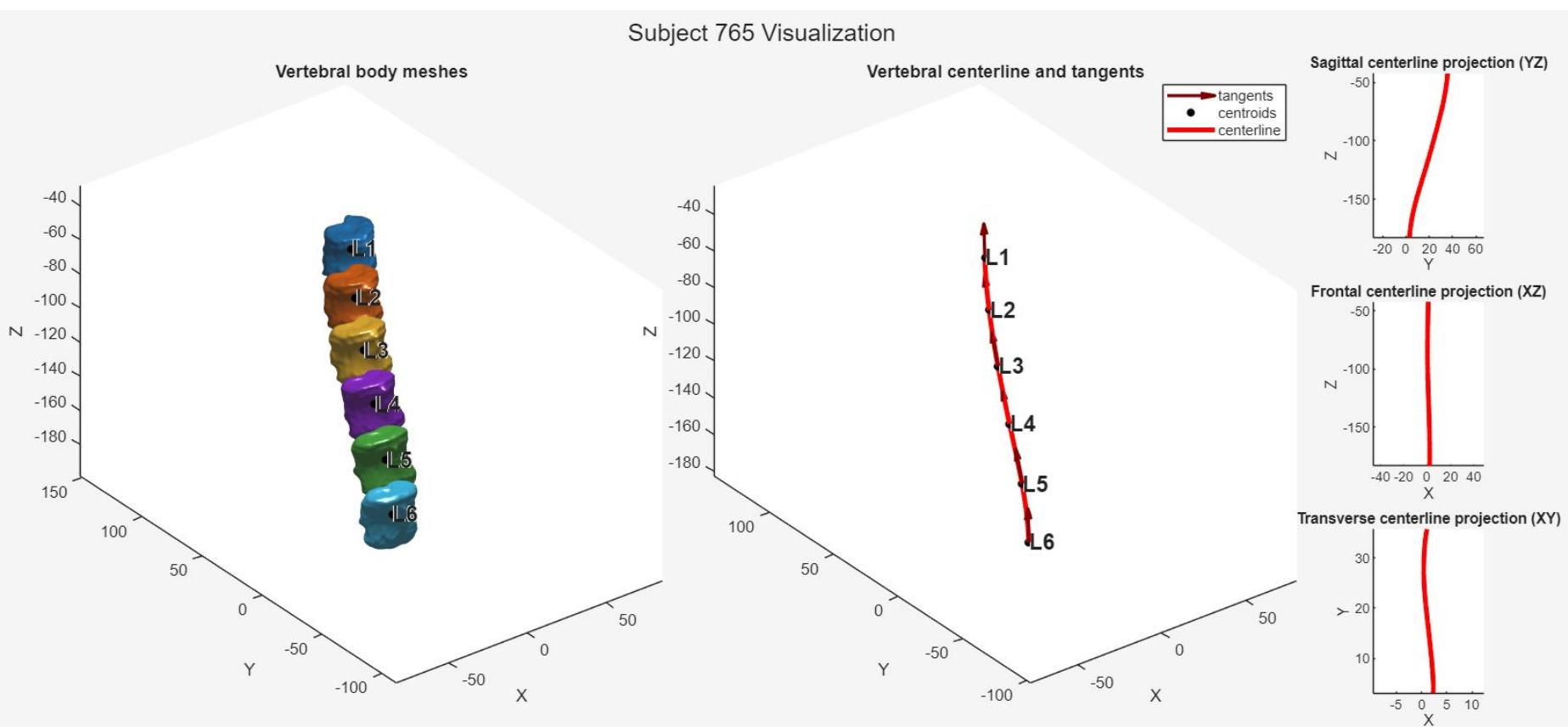
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[1] Github stats (as of 1/29/2026): total # lines of code = 5,861, total # of words = 25,572, total # of characters = 228,566, total # of MATLAB .m files = 72

[2] Necessary MATLAB packages: Curve Fitting Toolbox

# MATLAB Program Overview

## 1.) Loading geometry: *loads vertebral body geometries & computes centerline path and tangents*



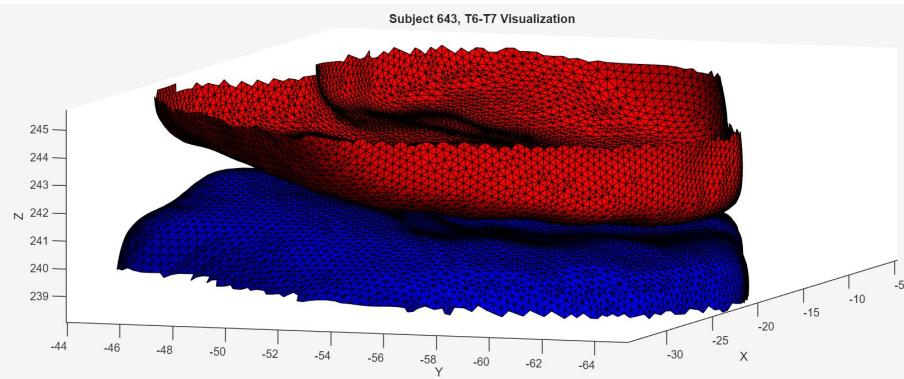
# MATLAB Program Overview

## 2.) Disc construction: *interpolating across vertebral endplates to define and export disc volumes*

### Step 1:

*Extract triangulation representations of superior + inferior surfaces*

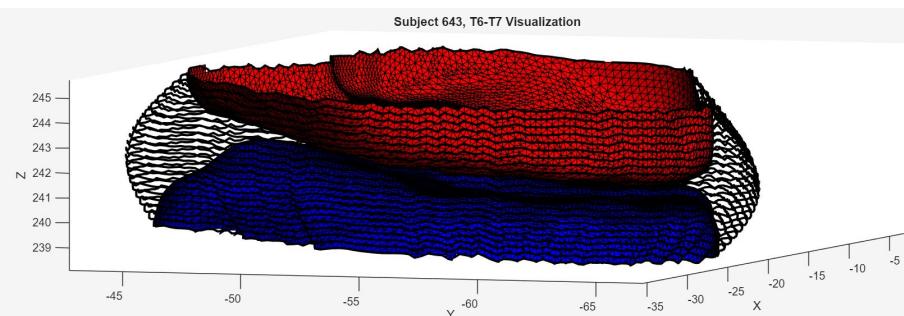
- Red = superior surface of disc
- Blue = inferior surface of disc



### Step 2:

*Obtain inferior → superior loft curves  
(pictured in black)*

- Associated parameters:
  - # of rings
  - bulge amplitude (default: 2 mm)

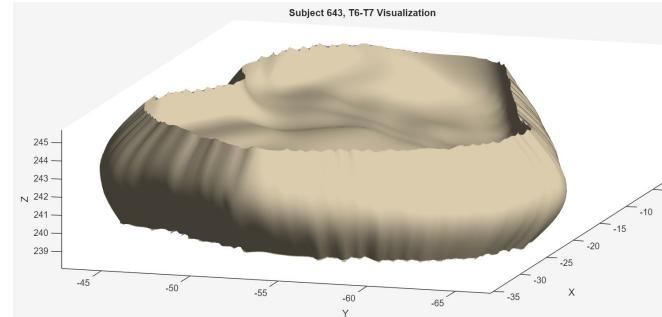


# MATLAB Program Overview

## 2.) Disc construction: *interpolating across vertebral endplates to define and export disc volumes*

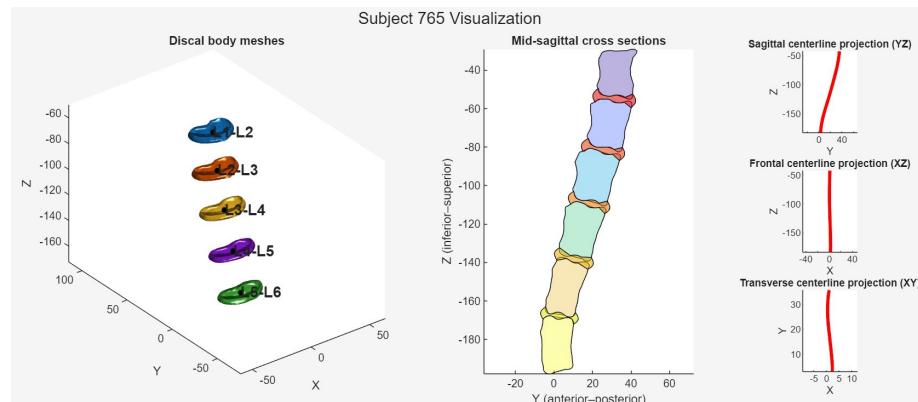
### Step 3:

*Stitch endplate surfaces to one another to create a full disc triangulation and export to .stl file*



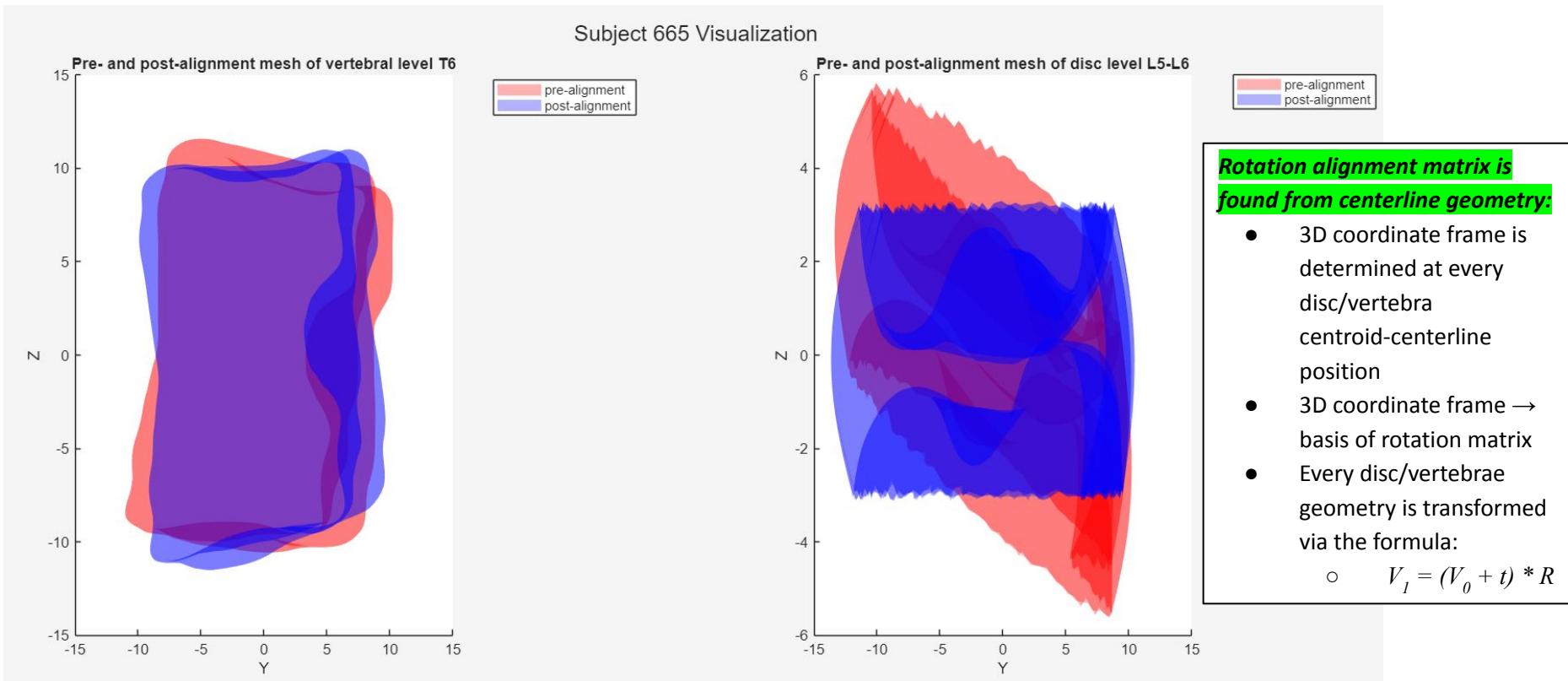
### NOTES:

- Water-tightness is NOT guaranteed
- Any further geometry processing and measurement processes are generalized for both vertebra and disc structures



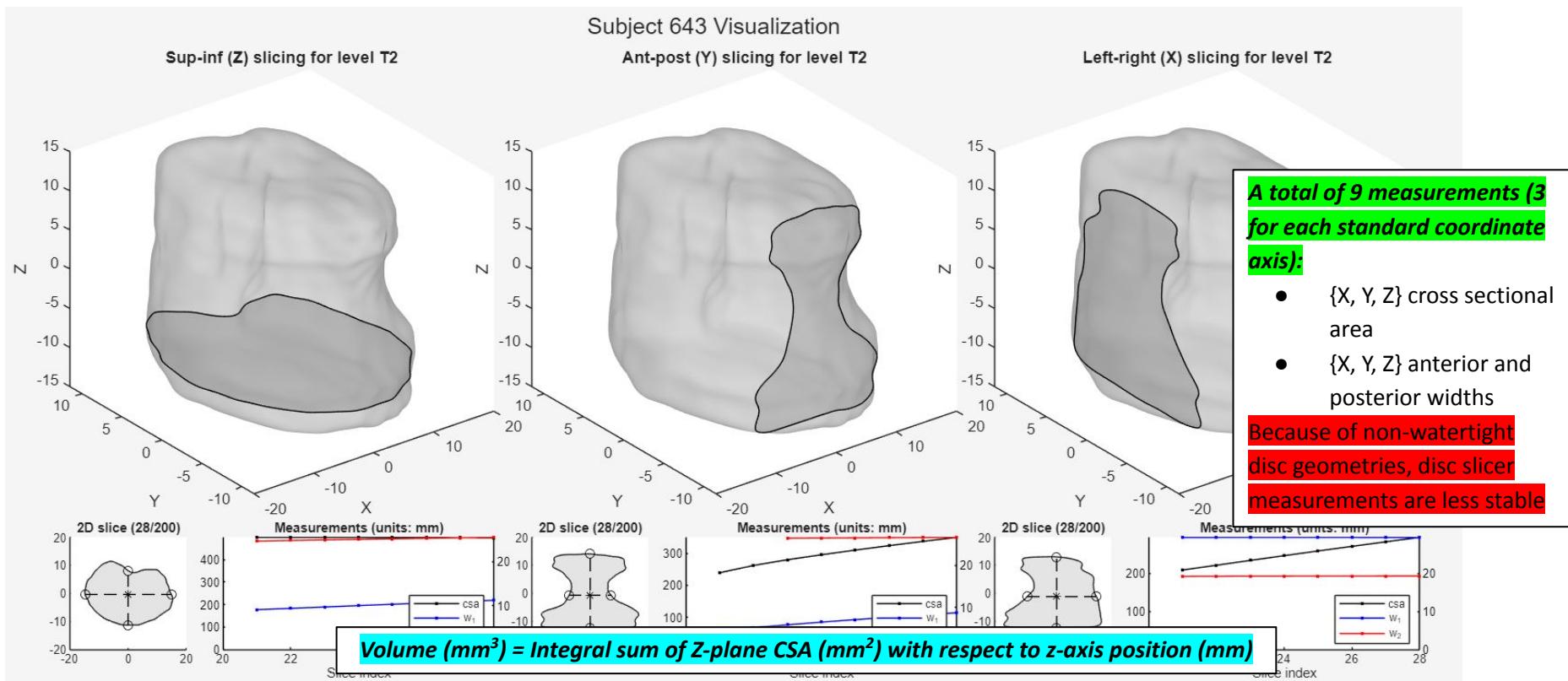
# MATLAB Program Overview

## 3.) Geometry alignment: centerline-based geometry alignment to standard coordinate reference frame



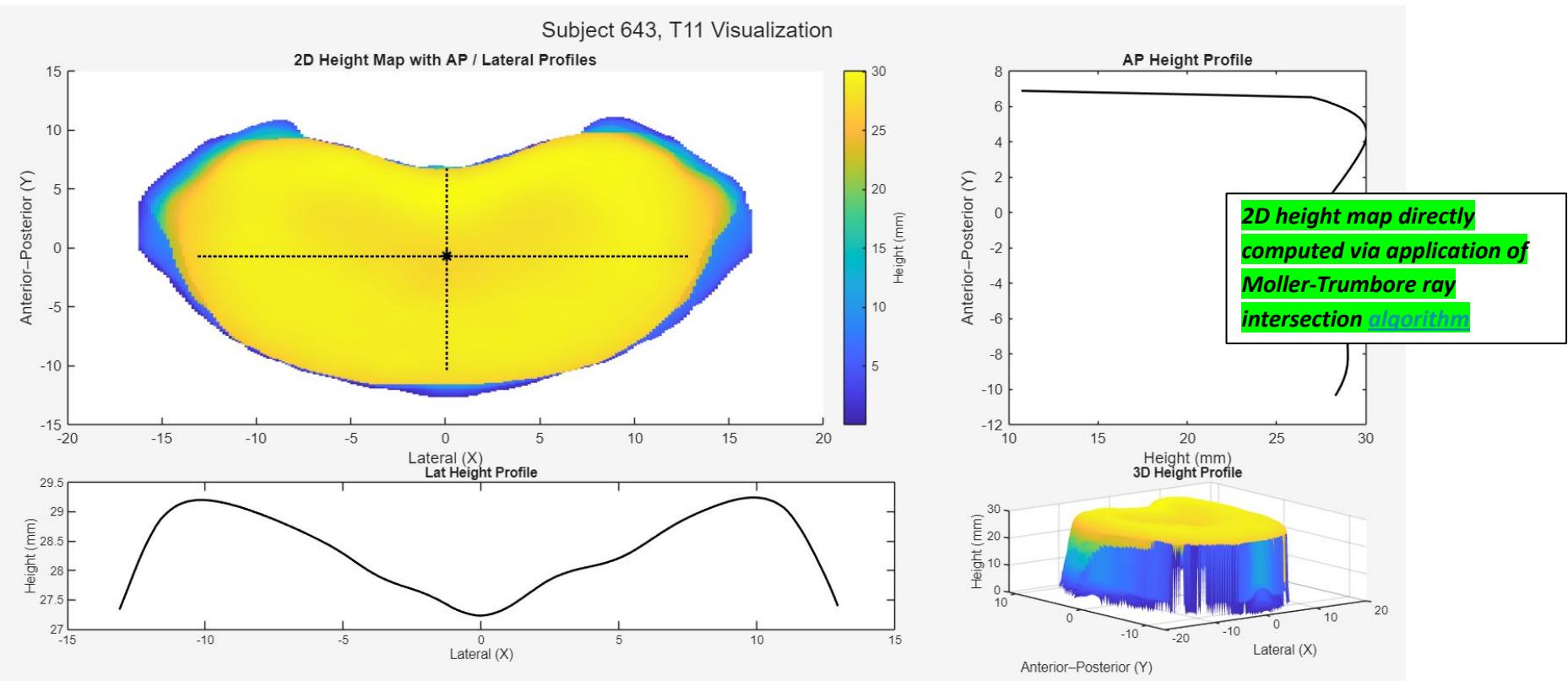
# MATLAB Program Overview

## 4.) Slicer/volume measurements: slicing geometries and measuring CSAs, widths, and volumes



# MATLAB Program Overview

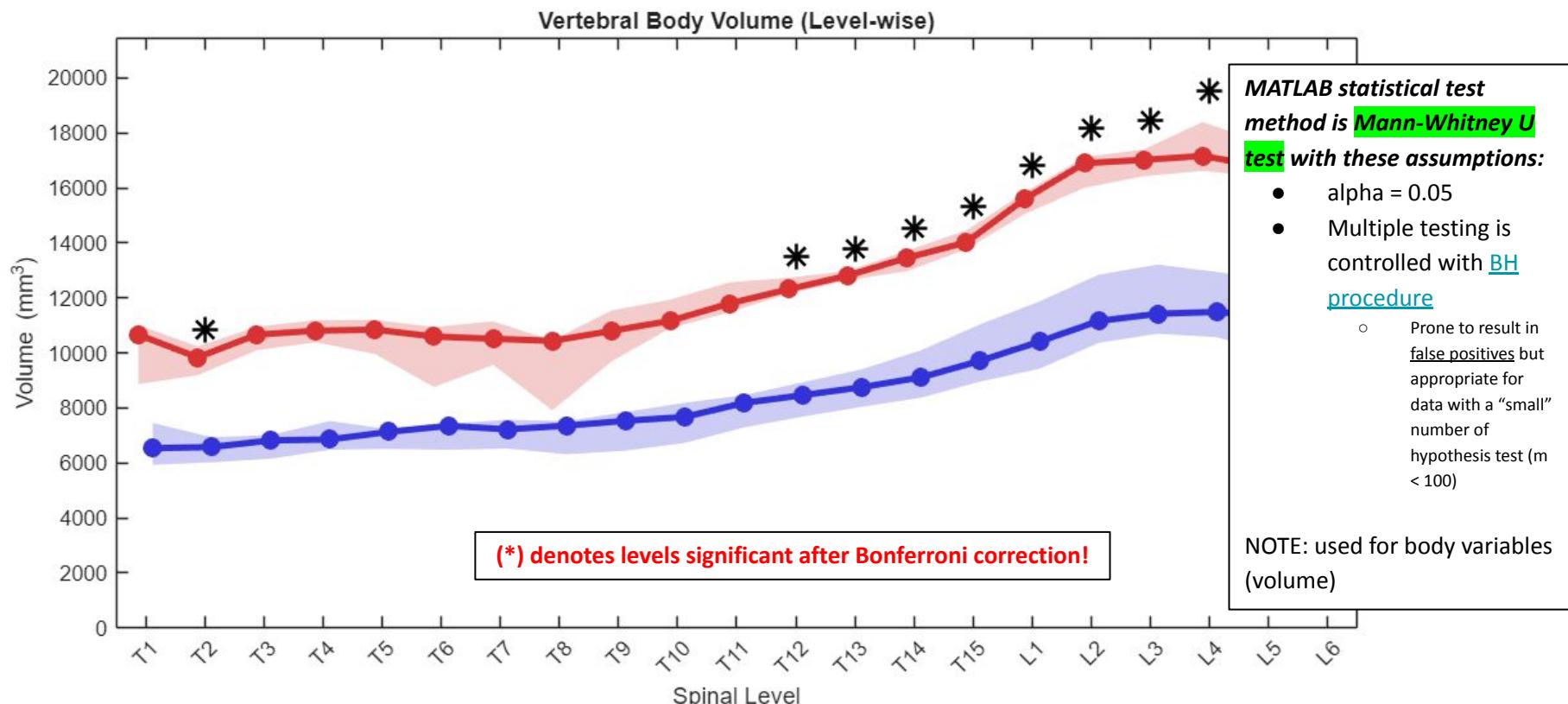
## 4.) Height measurements: measuring 2D height distribution and extracting AP and LAT heights



2D height map directly  
computed via application of  
Moller-Trumbore ray  
intersection algorithm

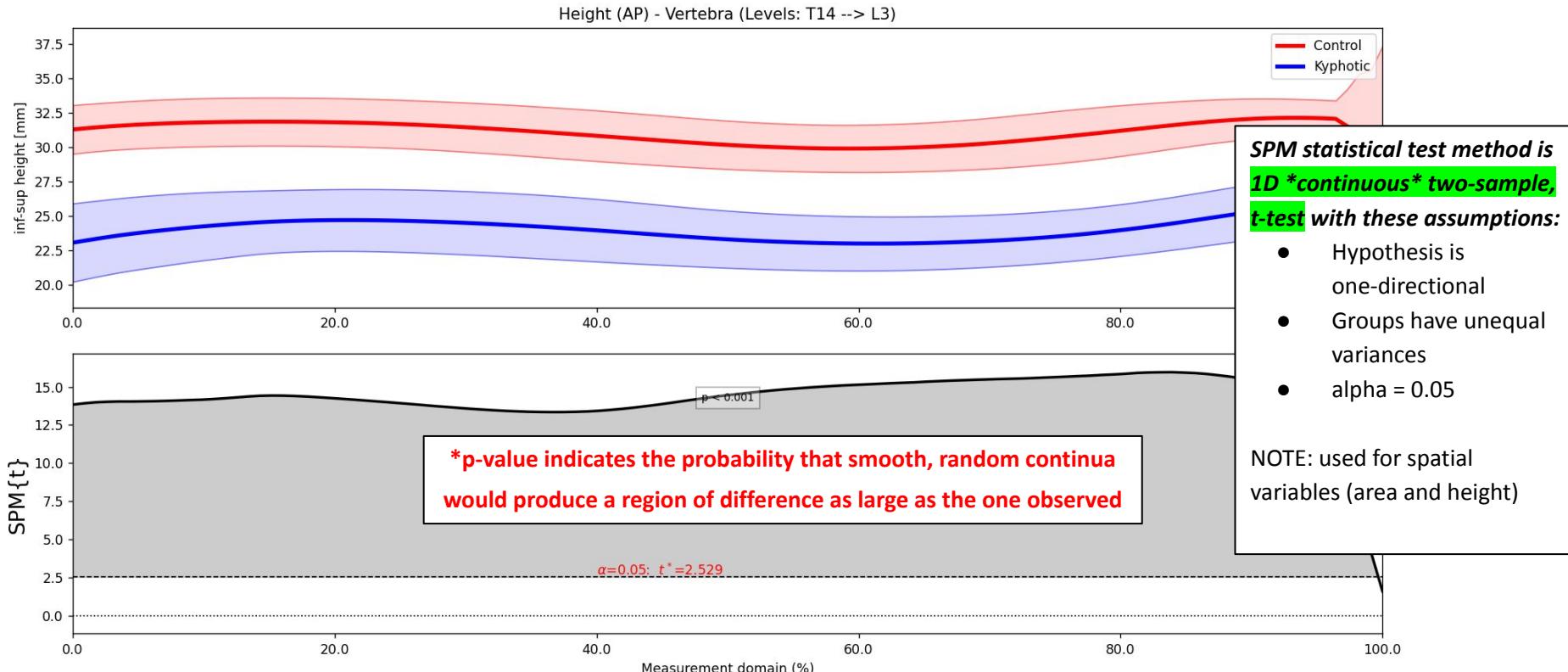
# MATLAB Program Overview

## 5.) Analysis: computing and visualizing summary statistics across control and kyphotic experimental groups



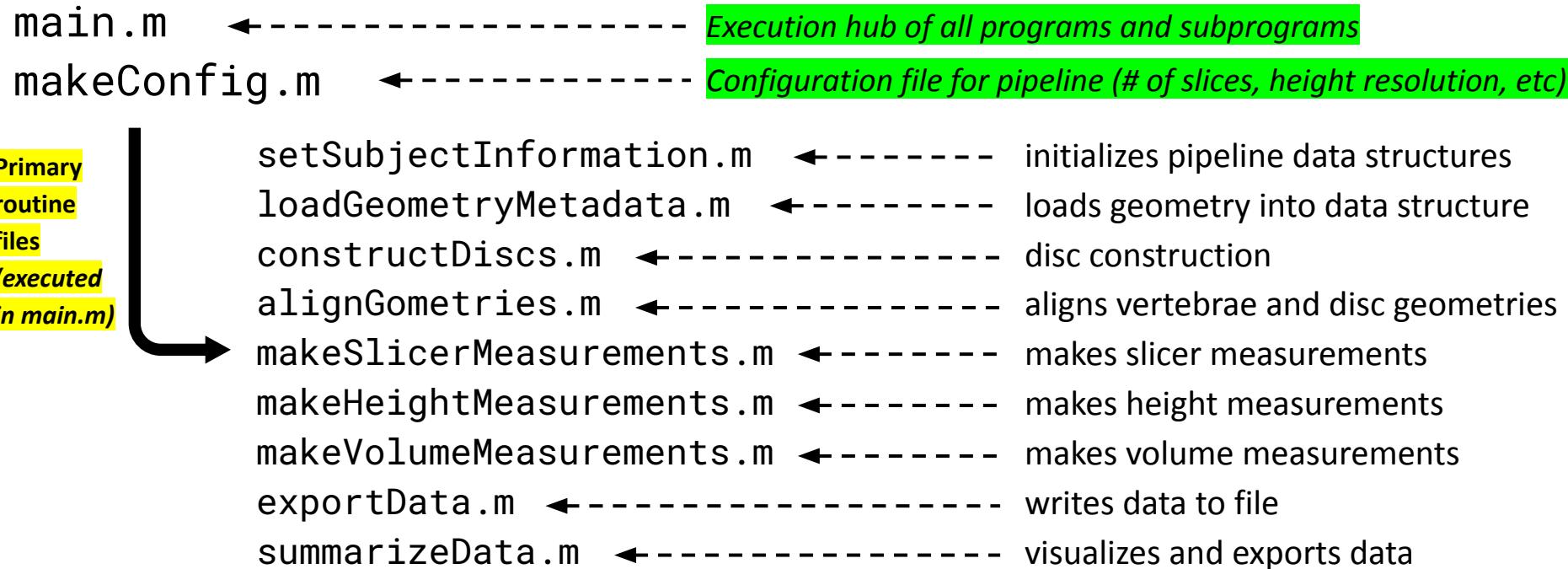
# MATLAB Program Overview

## 5.) Analysis: computing and visualizing summary statistics across control and kyphotic experimental groups



# Morphologies Technical Overview

**Morphologies** source code [here](#), head files:



# Morphologies Technical Overview

**Morphologies source code [here](#), head files:**

main.m ←----- *Execution hub of all programs and subprograms*

makeConfig.m ←----- *Configuration file for pipeline (# of slices, height resolution, etc)*

## How to use source code:

### 1. Set configuration settings in makeConfig.m

#### a. **IMPORTANT PARAMETERS:**

i. *numSlices, heightResolution, slicerIgnorance, heightIgnorance*

ii. *If pipeline detects any of these config parameters are different from the saved config settings in 'data/raw', the measurements will be rewritten!*

#### b. *Options for visualization (note: some plots are graphics intensive)*

#### c. *Disc construction parameters*

#### d. *Range of levels to be exported for SPM analysis*

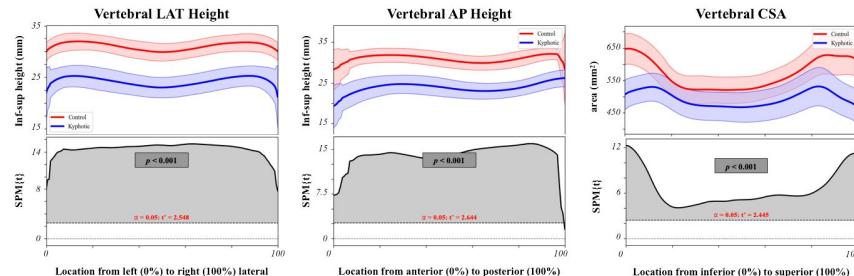
### 2. Run main.m for MATLAB results and run '[analysis-utils/main.py](#)' for SPM results

# Summary of Results from *Morphologies*

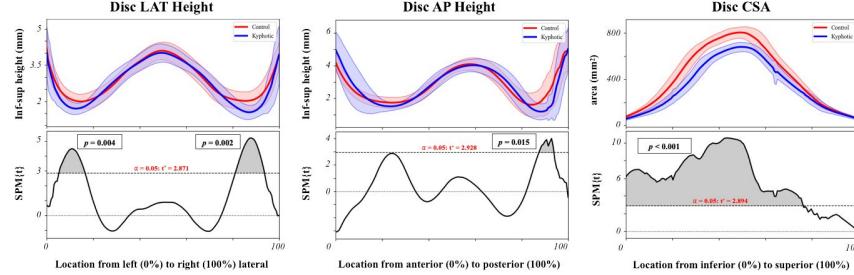
**Settings:** # of slices = 200, height resolution = 200, slicer & height ignorance = 0.1, **levels exported** = T14 → L3

## Spatially-varying measurements

**A**

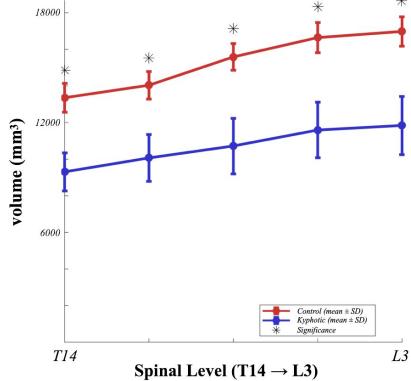


**B**

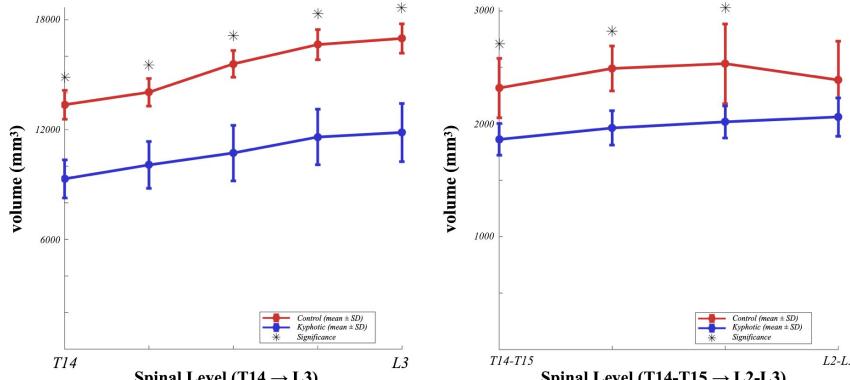


## Spine-level scalar measurements

### Vertebral Volume



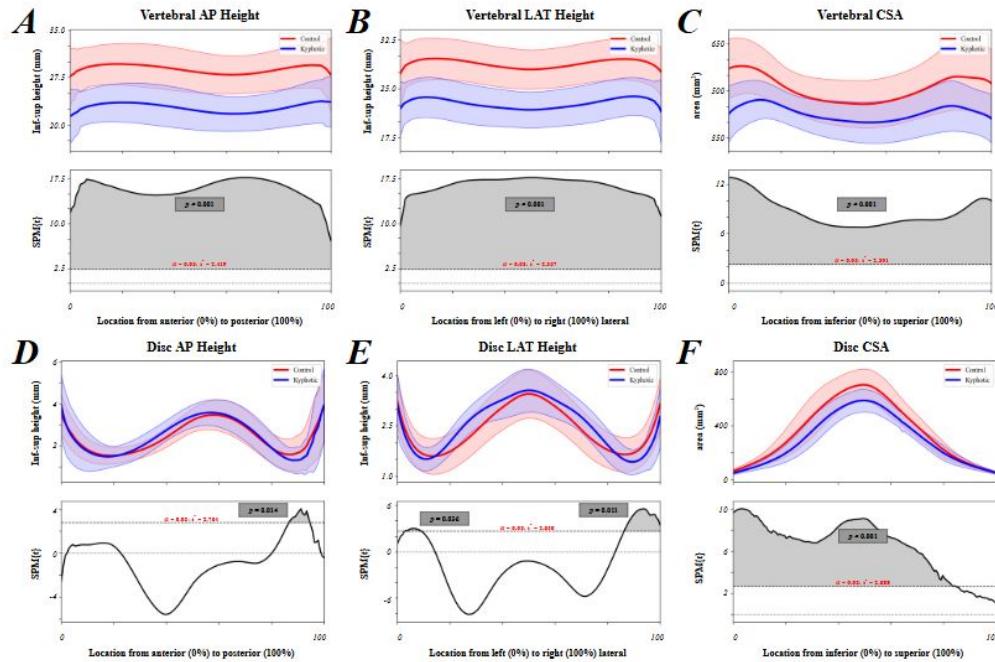
### Disc Volume



# Summary of Results from *Morphologies*

**Settings:** # of slices = 200, height resolution = 200, slicer & height ignorance = 0.1, **levels exported** = T1 → L6

## Spatially-varying measurements



## Spine-level scalar measurements

