Image Analysis and Geometry Reconstruction

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Advisor: Dr. Negin Forouzesh (Computer Science)

Meet the Team

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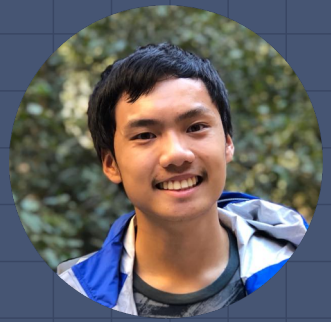

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Meet the Team

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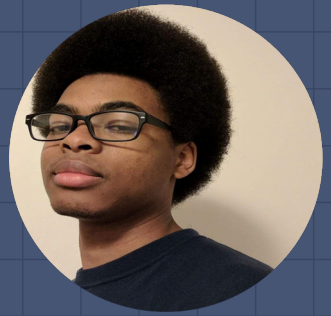

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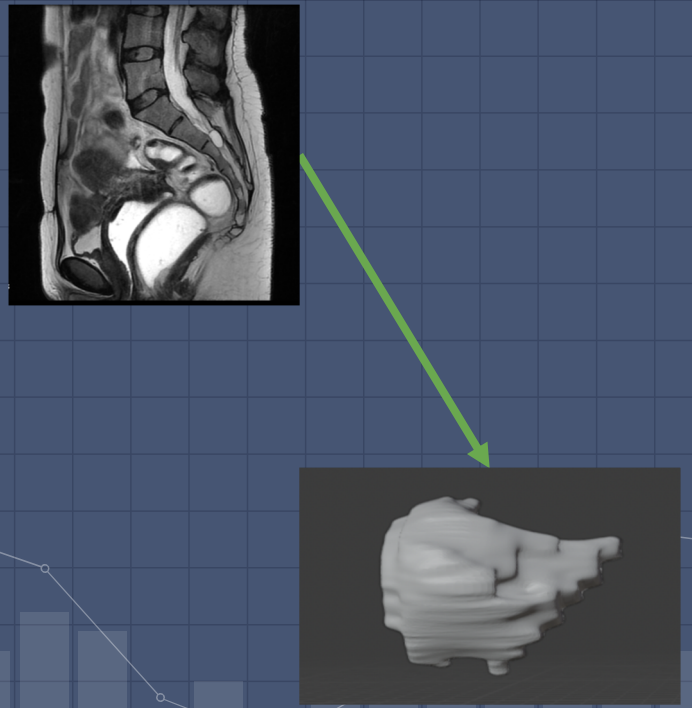
Problem

- Currently, it can be tedious to get a clear 3D model out from an MRI image.
- The process of improving the images is no less demanding
- There is a clinical need for a more efficient, easy-to-use solution

Goal

- Create a program that streamlines the 3D model-making process
- Integrate artificial intelligence into current process



Traditional Approach

INPUT

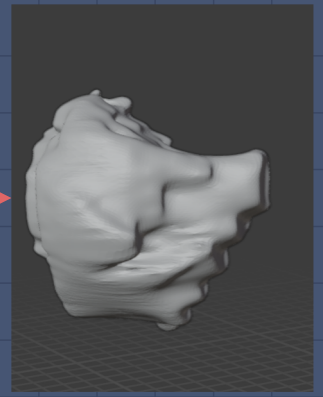
3D Slicer

Manual Threshold

CREATE

Blender

REFINE



OUTPUT

Team's Approach

INPUT

DICOM Cleaner

ANONYMIZE

3D Slicer

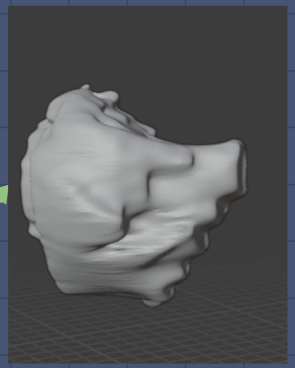
Manual Threshold

Nvidia AIAA

Auto-Segmentation

Boundary Points

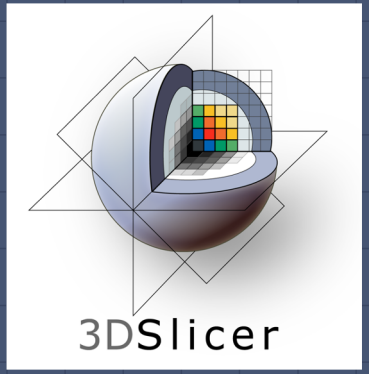
Deep Grow



OUTPUT

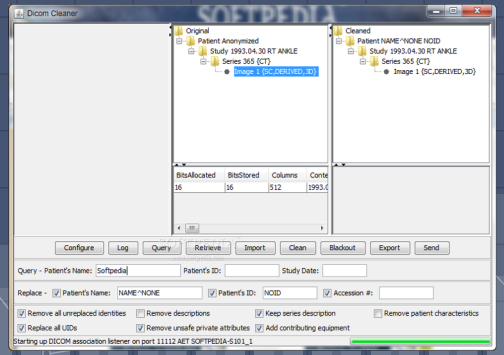
Used Software

3D Slicer

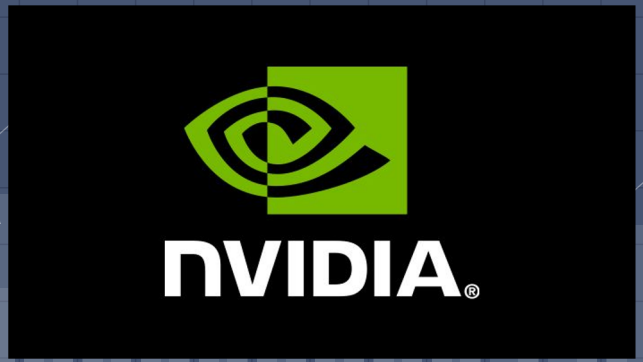


Blender

Dicom Cleaner

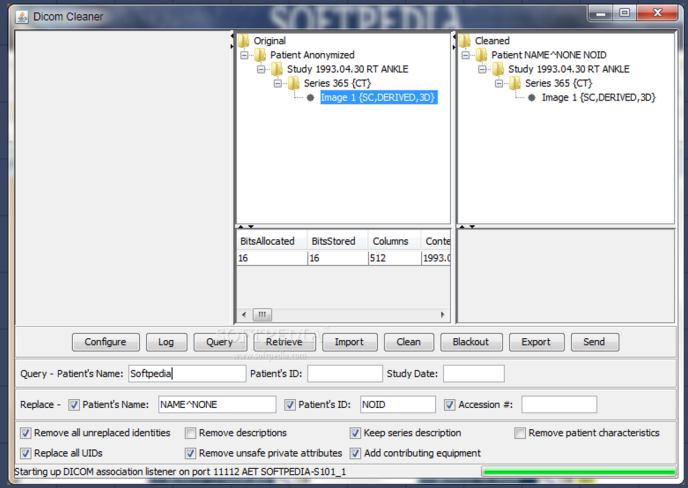


[Plugin] Nvidia AIAA



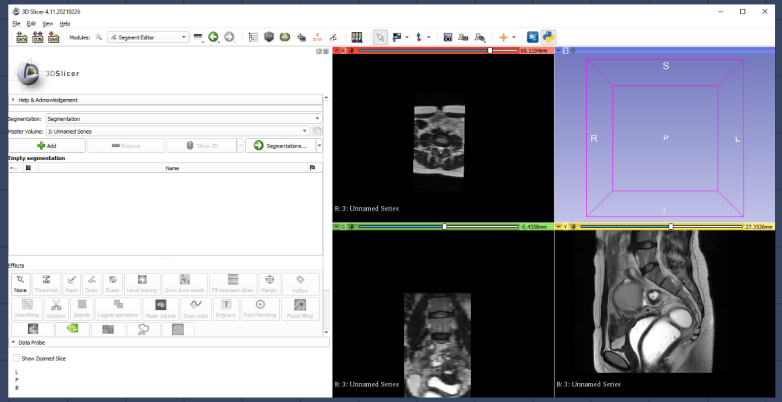
Dicom Cleaner

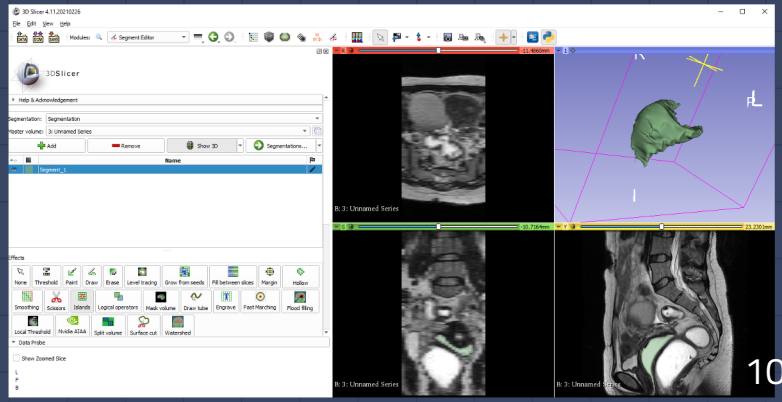
- Clean private/anonymized data



3D Slicer

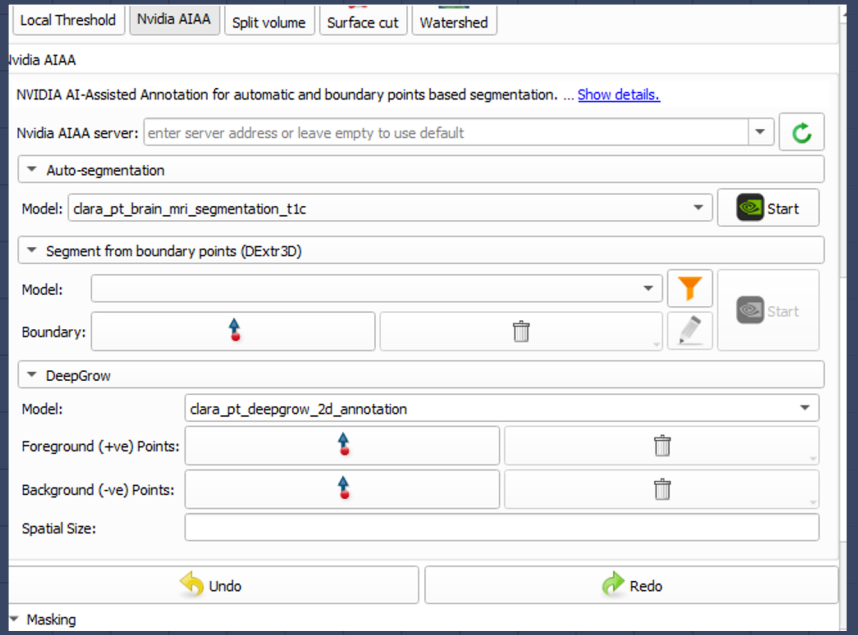
- Open Scans
- Focus on Area of Interest
- Form 3D from 2D
- Export STL files





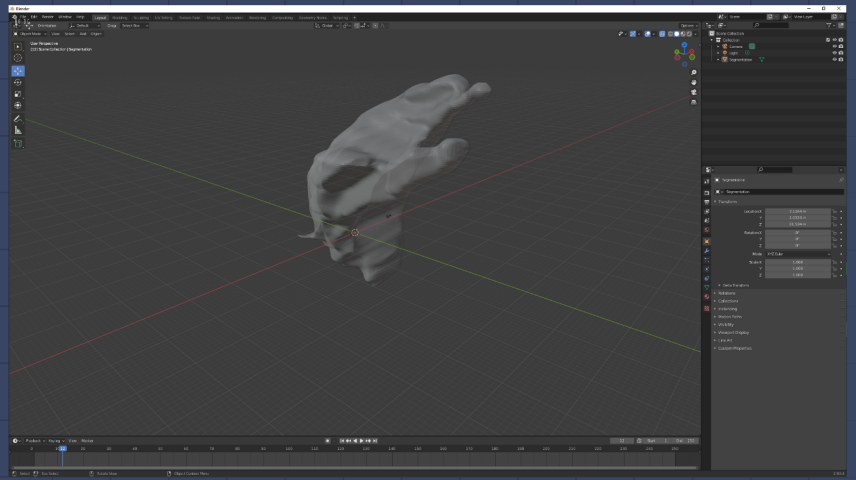
Nvidia AIAA

- AI Assisted Annotation
- Plugin
- Lower skill requirement
- Automate



Blender

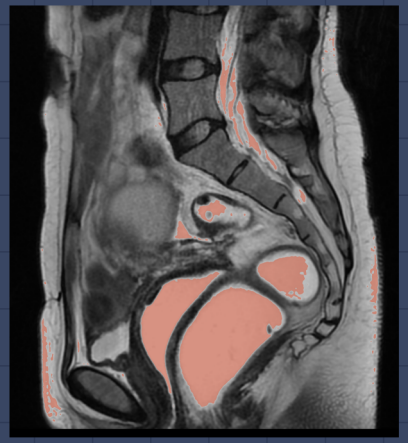
- View
- Manipulate
- Smoothing



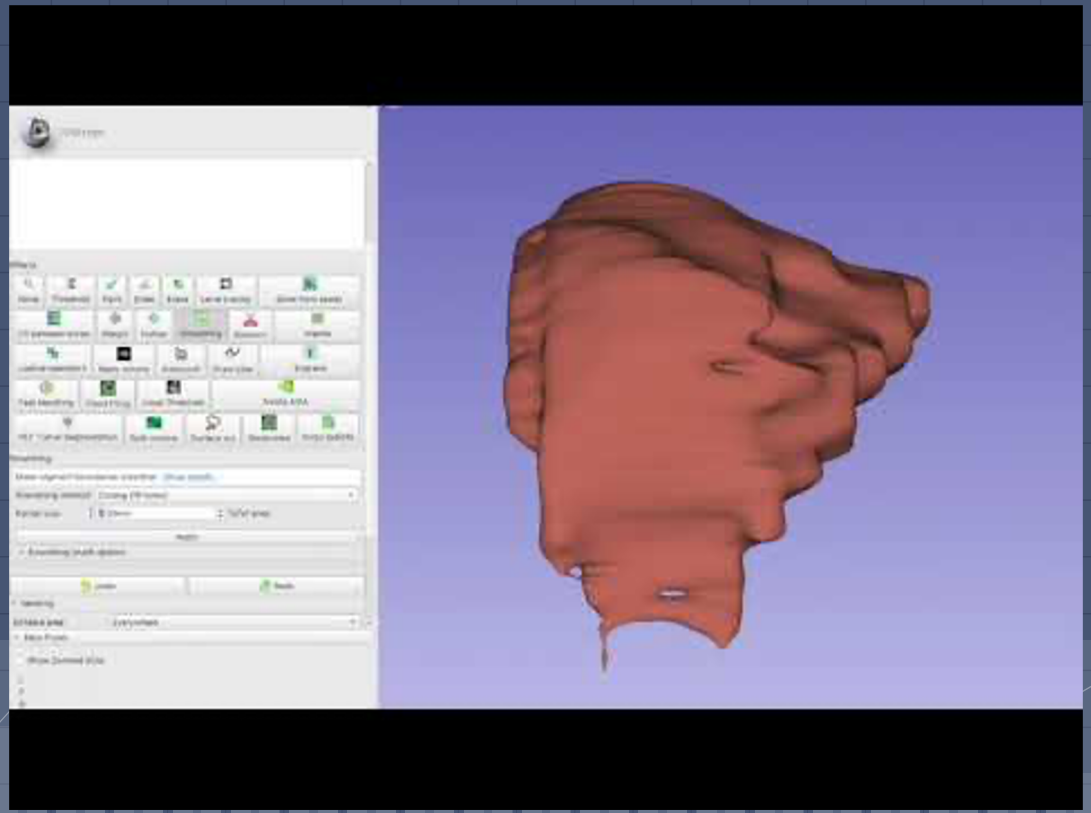
Manual Thresholding (Traditional Method)

Method #1: Manual Thresholding (Traditional Method)

Start from scratch and use traditional, manually used techniques to get the best possible 3D shape and output of the female pelvis and its specific key organs



DEMO: Method #1: Manual Thresholding (Traditional Method)



Method #1: Manual Thresholding
(Traditional Method)

Pros

- Very fast and effective
  - Threshold
  - Islands
  - Smoothing
- Requires less time for CPU clock speed

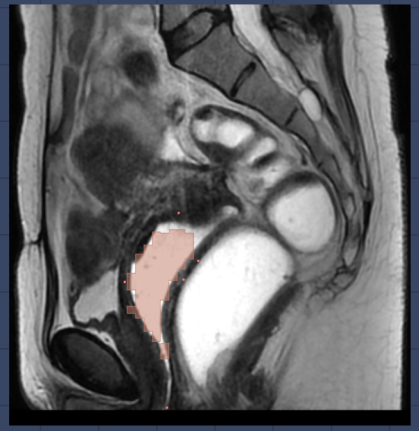
Cons

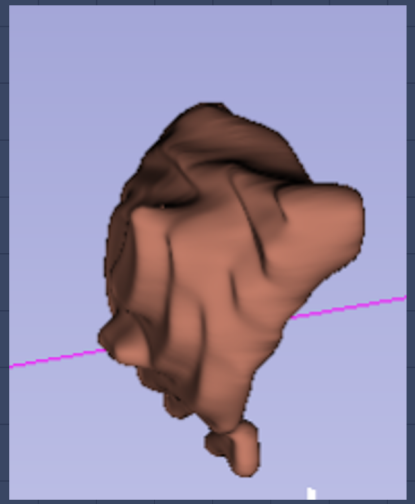
- Refinement takes time
  - Paint
    - Paint edges that need filling in the gaps
  - Scissors
    - Cut unnecessary fillings, trim sides

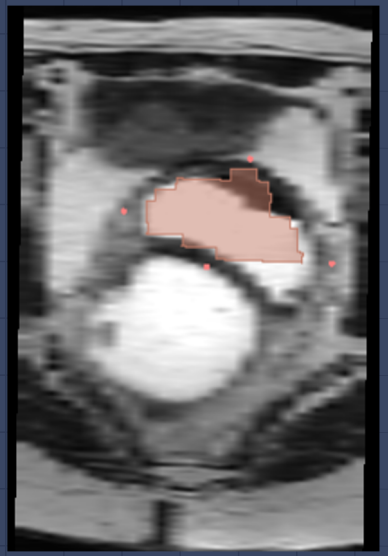
Nvidia AIAA: Boundary Points

Method #2: Nvidia AIAA (Boundary Points)

Requires user to specify input points near the edge of the structure of interest, one on each side to create a 3D model of specific organs in the female reproductive system.







DEMO: Method #2: Nvidia AIAA (Boundary Points)

Method #2: Nvidia AIAA (Boundary Points)

Pros

- Segmentation typically takes less than a minute.
  - Very little input required from user.
- Better accuracy than Manual Thresholding

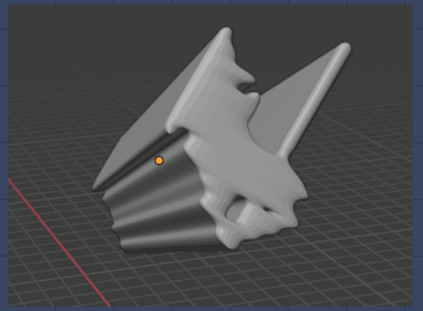
Cons

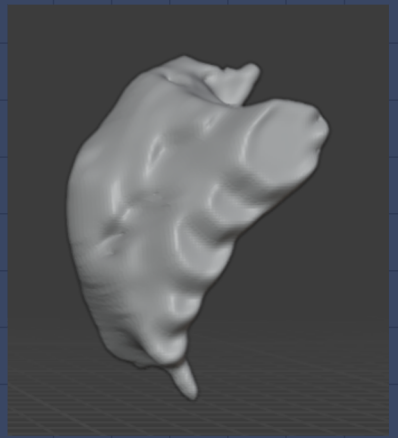
- Inconsistent - the organ can be distorted due to lack of Vagina, bladder or rectum model.
- Incompatibility with editing tools - eraser, scissors and drawing switched the shape of the organ

Nvidia AIAA: DeepGrow

Method #3: Nvidia AIAA (Deep Grow)

Requires user to specify few input points (foreground/background) on the structure of interest. This is a 3D operation.





DEMO: Method #3: Nvidia AIAA (Deep Grow)

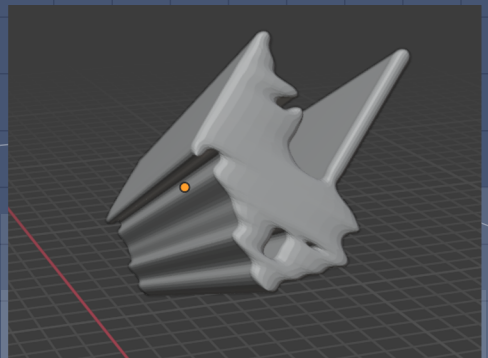
Method #3: Nvidia AIAA
(Deep Grow)

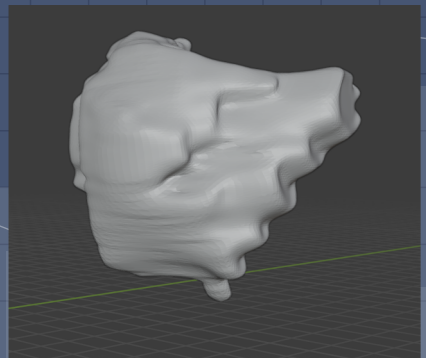
Pros

- Less input from user
  - Works like Boundary points
- Straightforward Refinement
  - Foreground Points
  - Background Points
- Clear 3D model

Cons

- Inconsistent
  - Worked for some members and not others
- Time of completion
  - Each single point typically takes about 4 seconds.





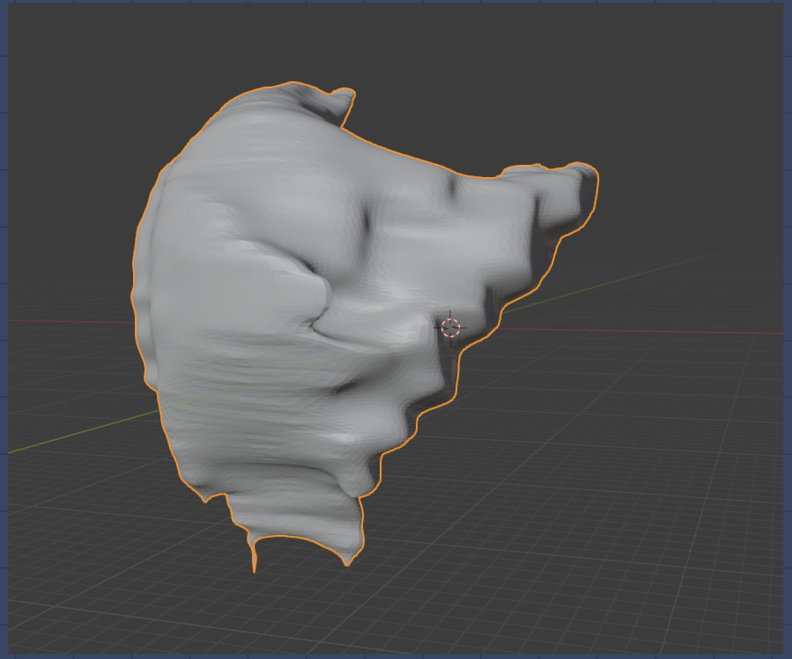
Methodology Comparison

Purpose

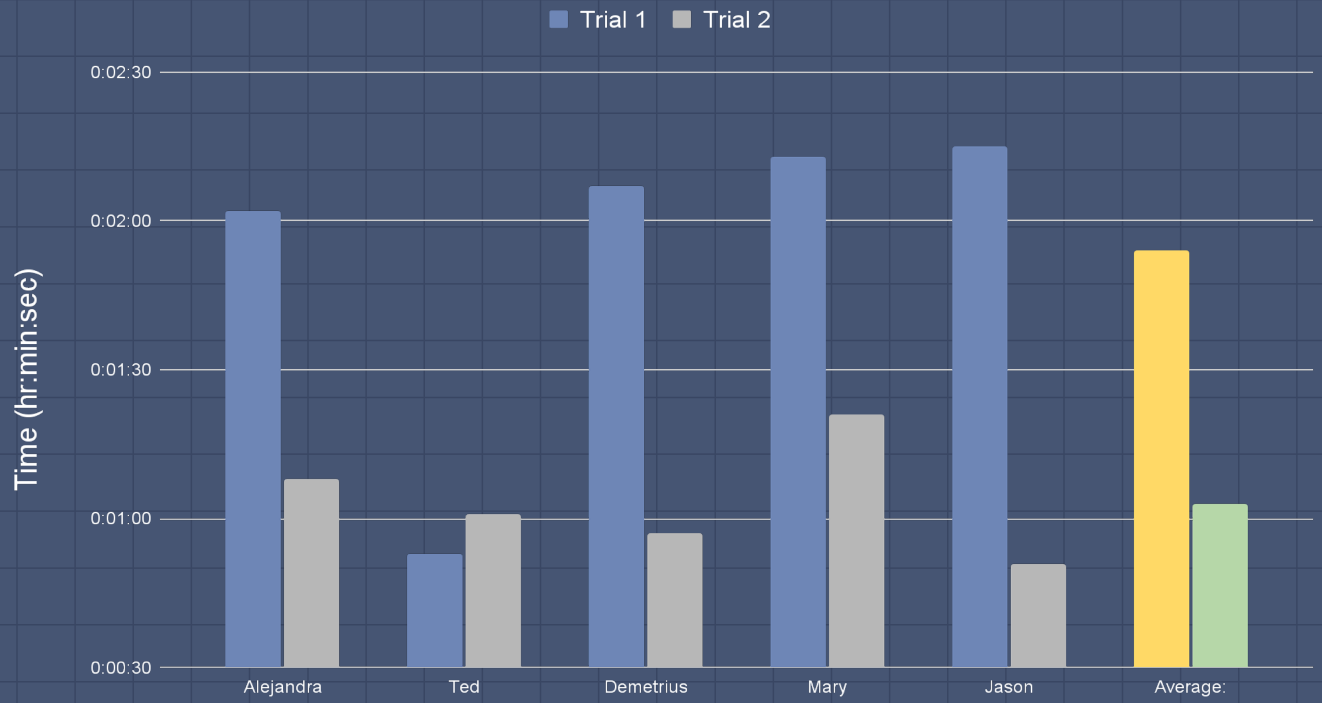
- **Time**
  - How long to produce a model.

- **Accuracy**
  - The quality of the model produced.

Traditional Method (Manual Thresholding)



Manual Thresholding

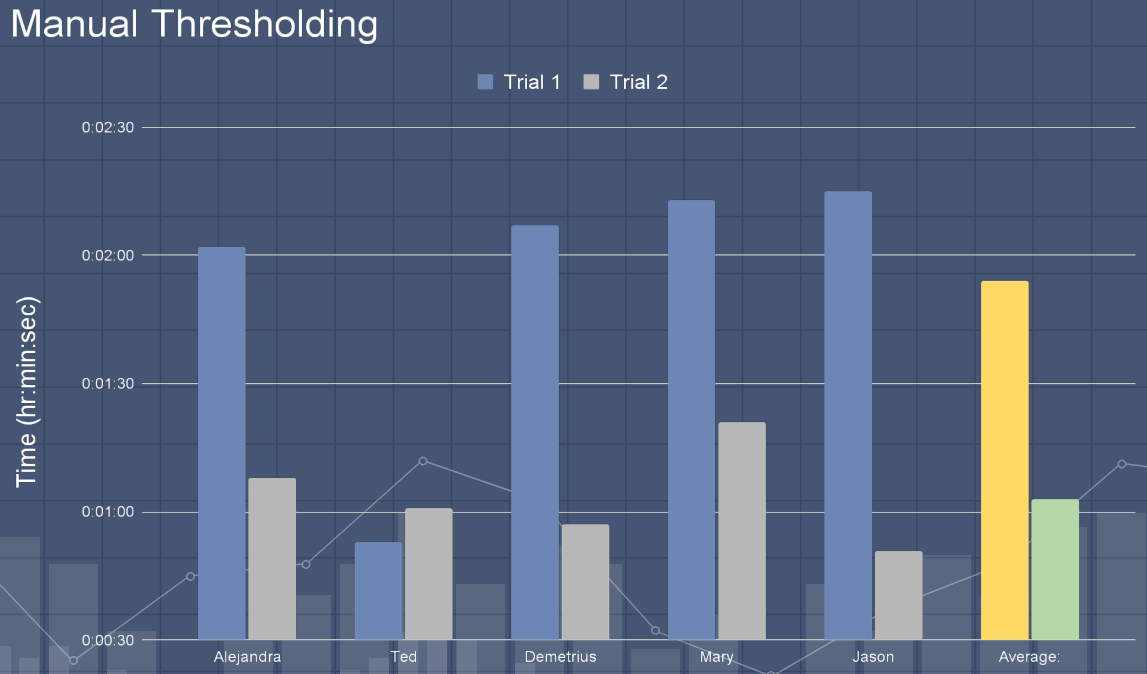


Manual Thresholding time comparison chart

Demetrius

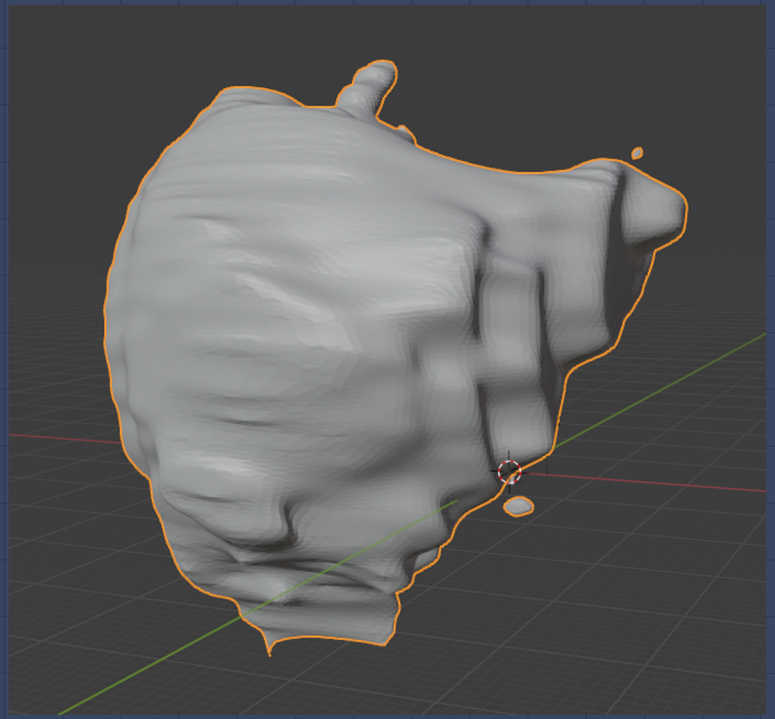
Reported times are biased

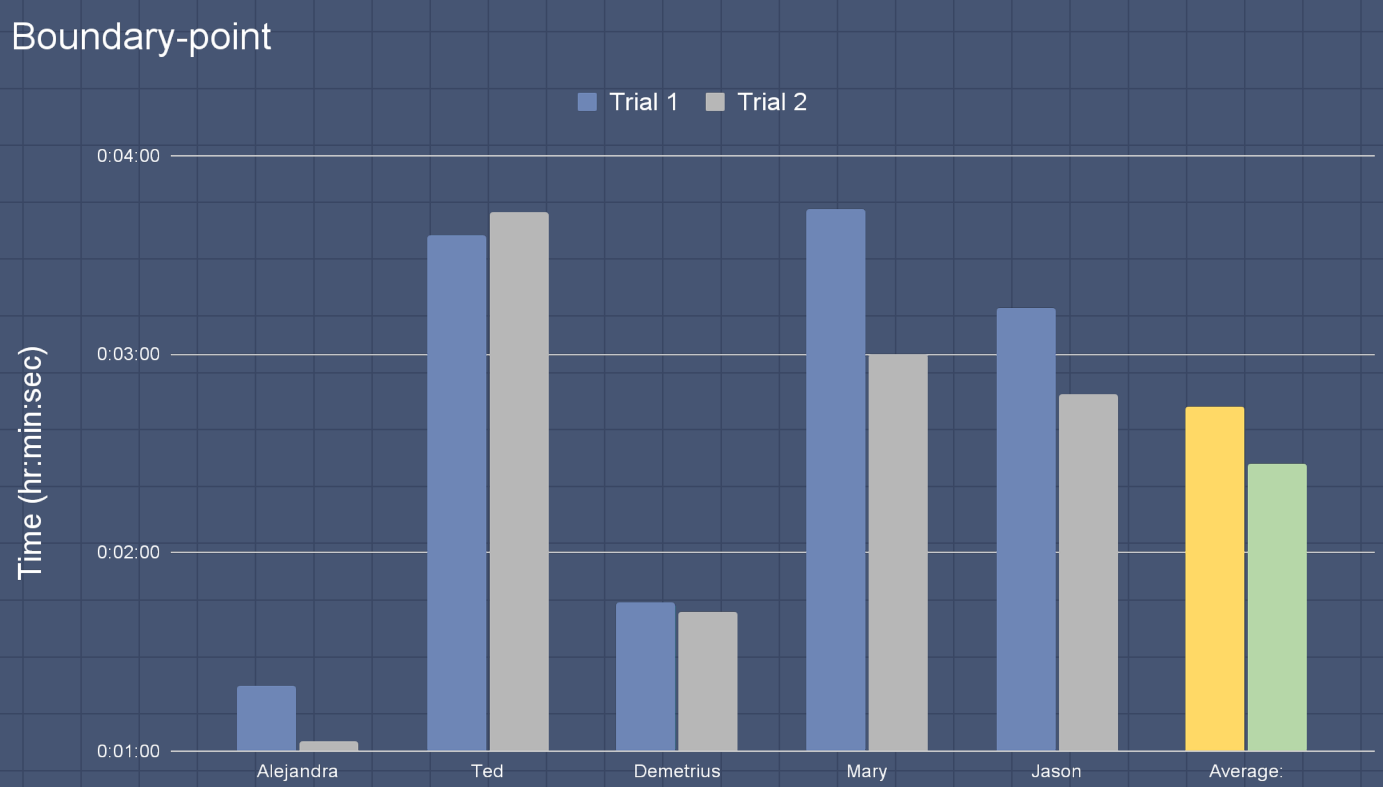
- **Guidance**
  - List of instructions
- **Familiarity**
  - Experience
- **Hardware**
  - Different computers



Demetrius

Boundary Points



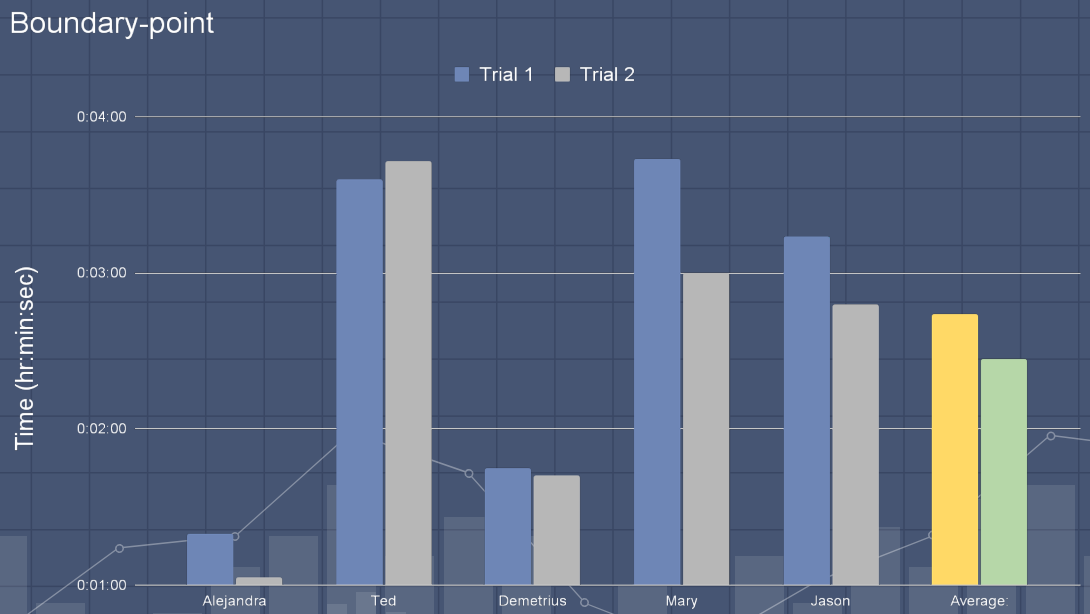


Boundary-point time comparison chart

Demetrius

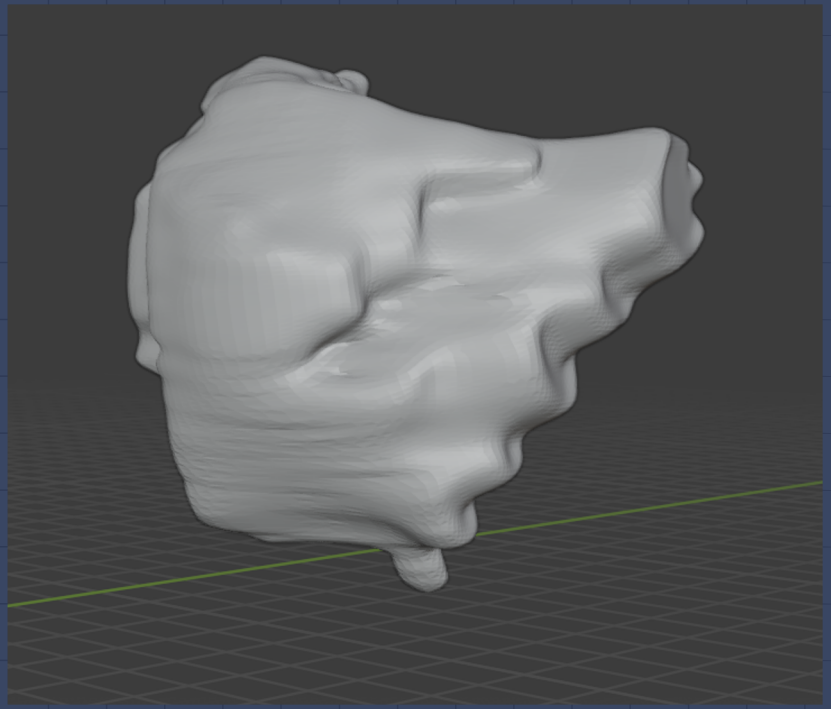
Reported times are biased

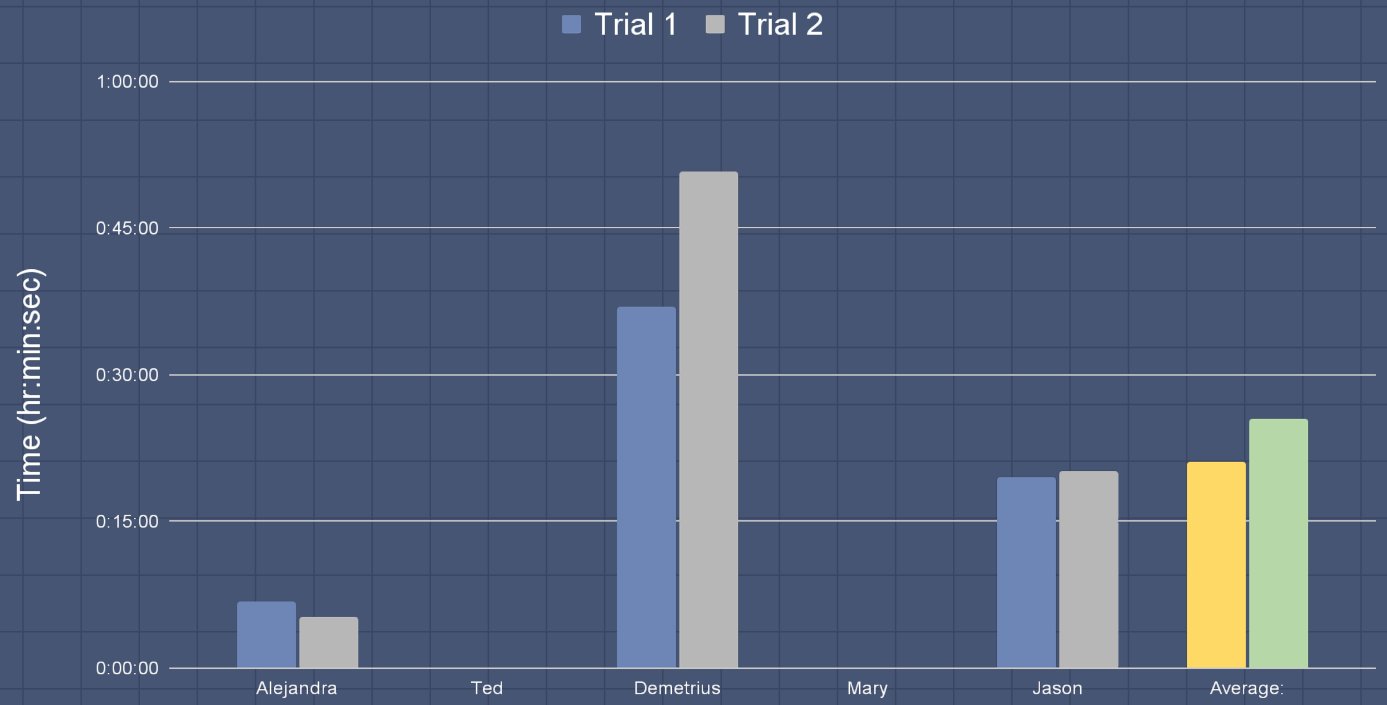
- **No guidance**
  - No set instructions
- **Hardware**
  - Different computers



Demetrius

Deep Grow



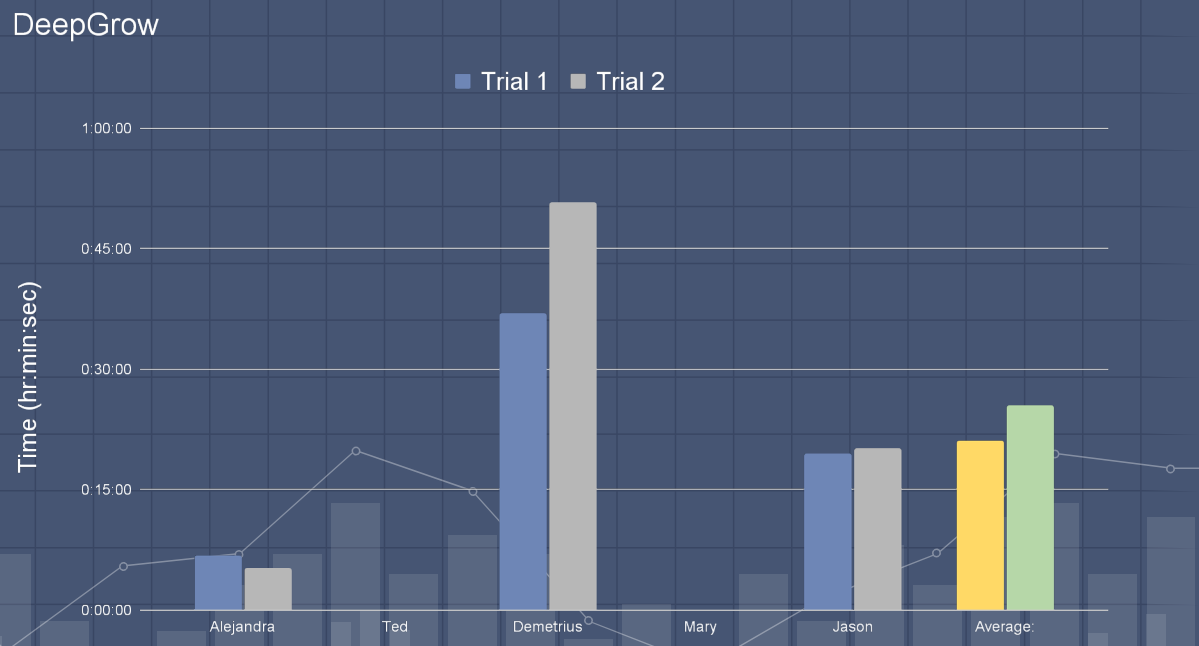


DeepGrow time performance comparison chart.

Demetrius

Reported times are biased

- **No guidance**
  - No instructions.
- **Hardware**
  - Different computers



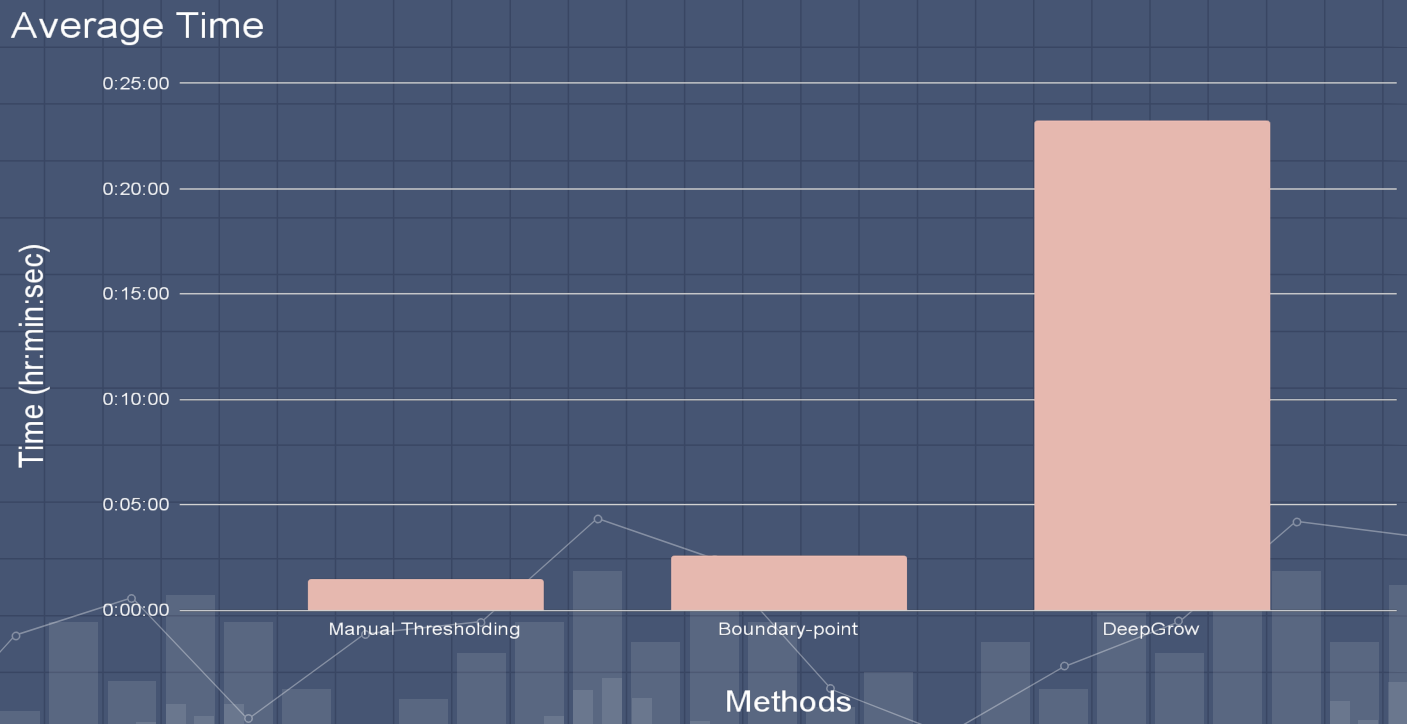
Demetrius

Average

Traditional
- 1 minute 29 seconds.

Boundary
- 2 minutes 36 seconds.

DeepGrow
- 23 minutes 16 seconds.



Time Results

Traditional

Fastest but requires training.

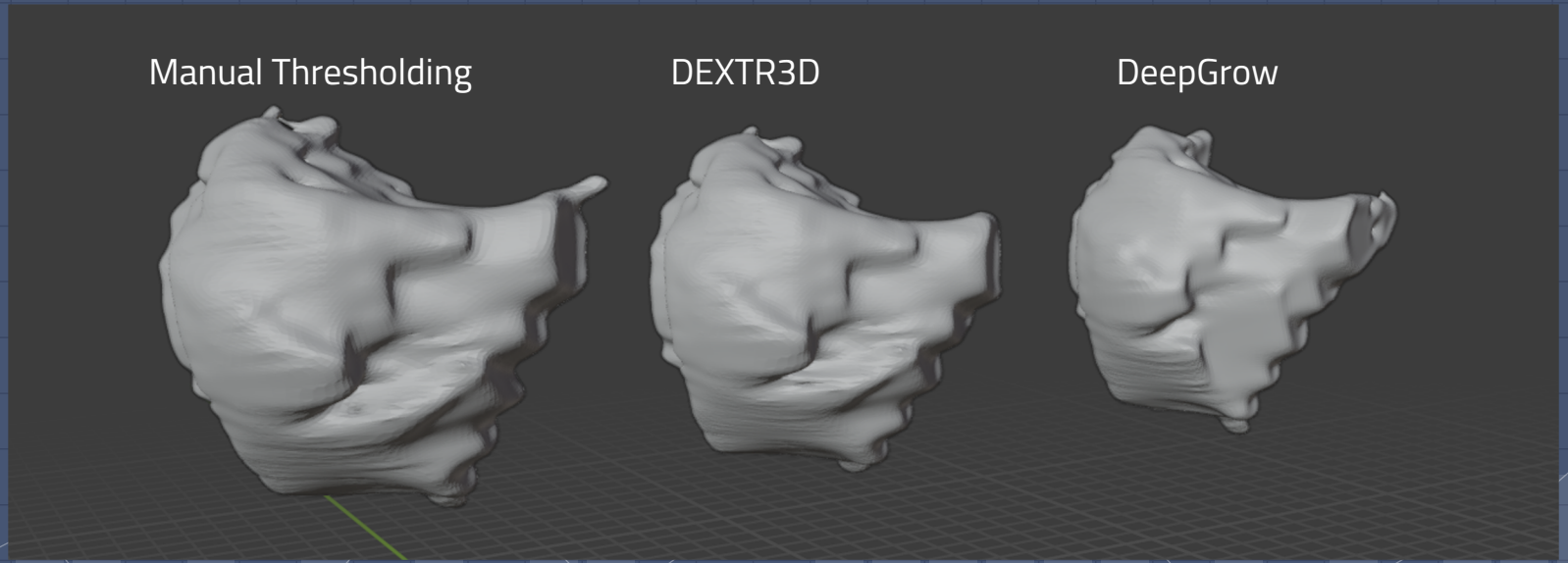
Boundary

Slightly longer than Traditional but does not require training

DeepGrow

We will not use due to quality amount of time.

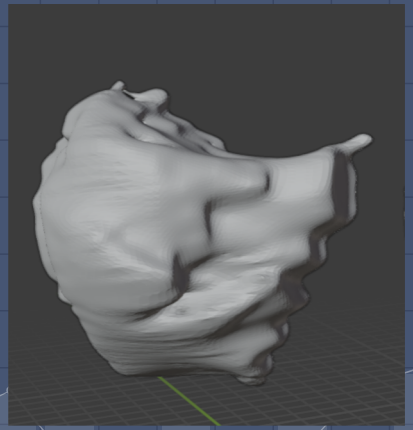
Accuracy Comparison



Accuracy Results

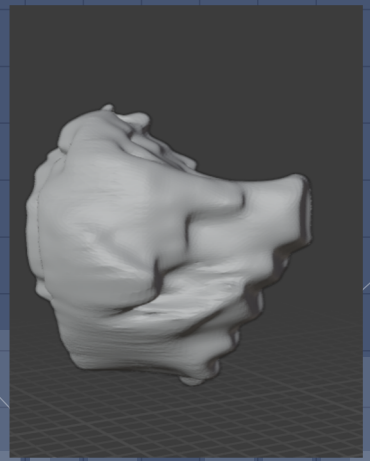
Traditional

Accurate but requires smoothing.



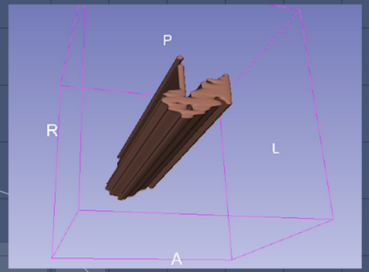
Boundary

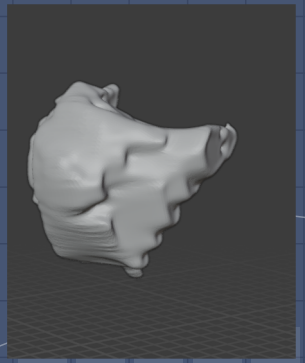
More accurate than traditional but still requires smoothing



DeepGrow

Most accurate but not reliable due to quality inconsistency and amount of time.





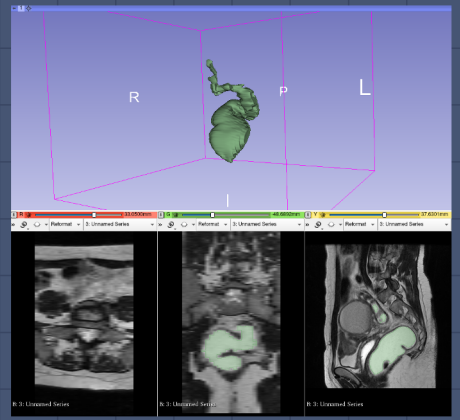
Challenges (Fall Semester)

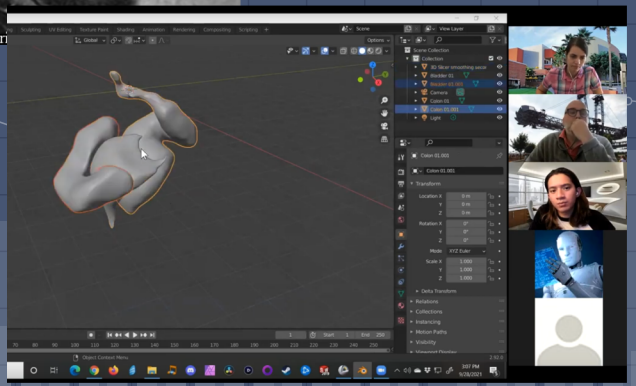
Understanding the context

- Learning about female pelvic anatomy
- Identifying the bladder, vagina, and rectum

Learning Curve with 3D Slicer

- Learning how to create a 3D model using traditional methodology
- Identifying & modeling the right organs in 3D Slicer





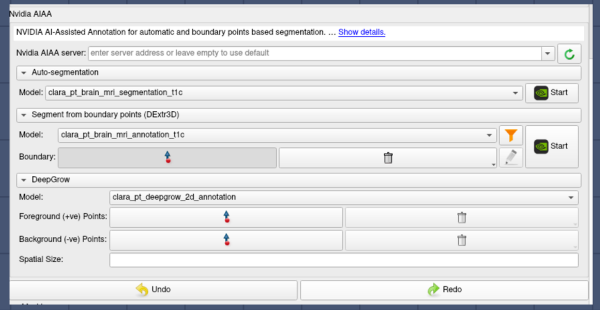
Challenges (Fall Semester)

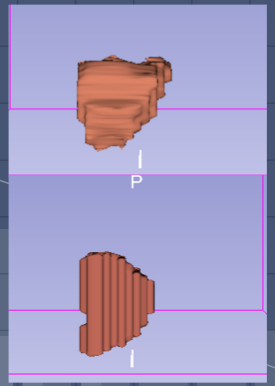
Learning Curve with Nvidia AIAA

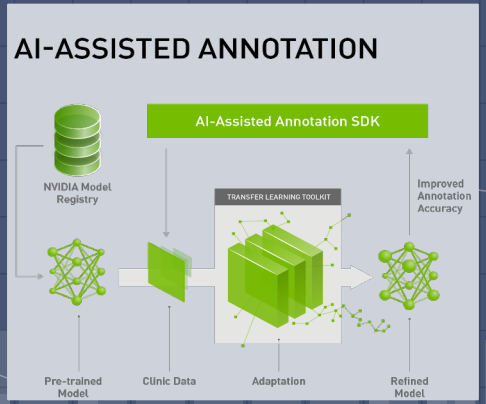
- Learning how to use Boundary Points and DeepGrow using available models from Nvidia

Privacy (& Getting More Data?)

- Preserving patient anonymity
- Storing sensitive data on servers
- Finding more MRI scans to work with



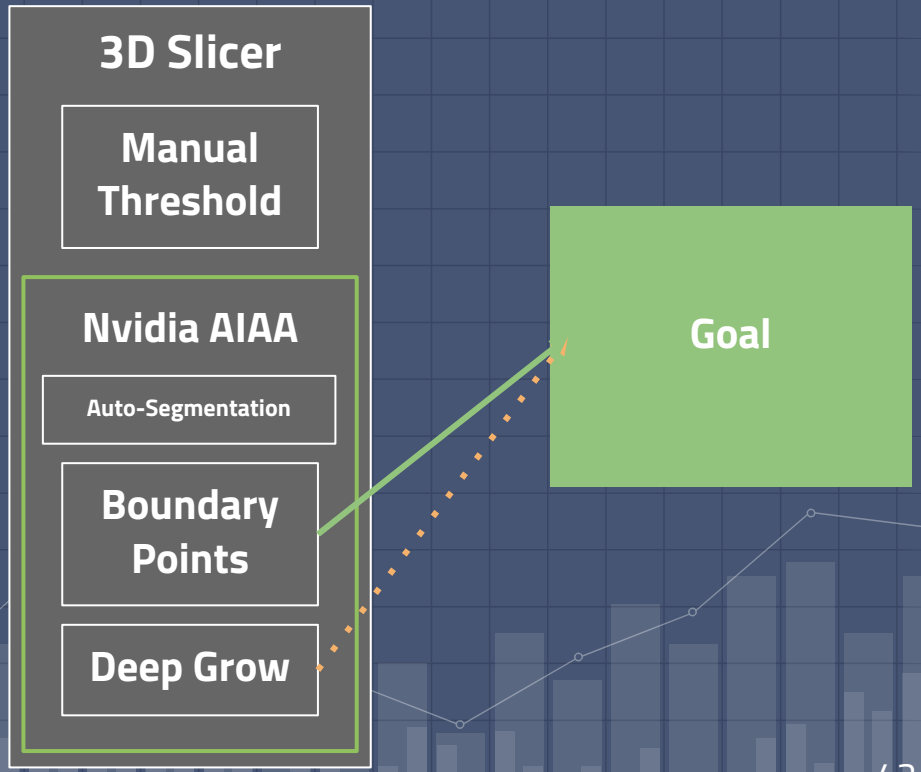




Current Prospect

Focusing on “Boundary Points”

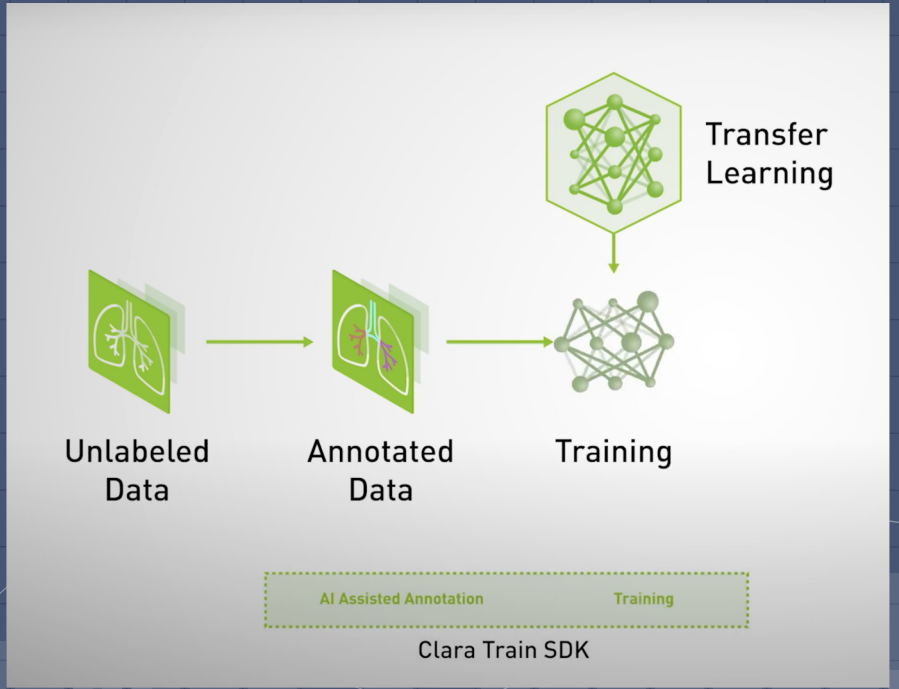
- Out of the 3 Nvidia AIAA features, Boundary Points is the most **consistent**
- Currently using brain model, hence the need to create our own female pelvic model



Current Prospect

Exploring Clara Train SDK

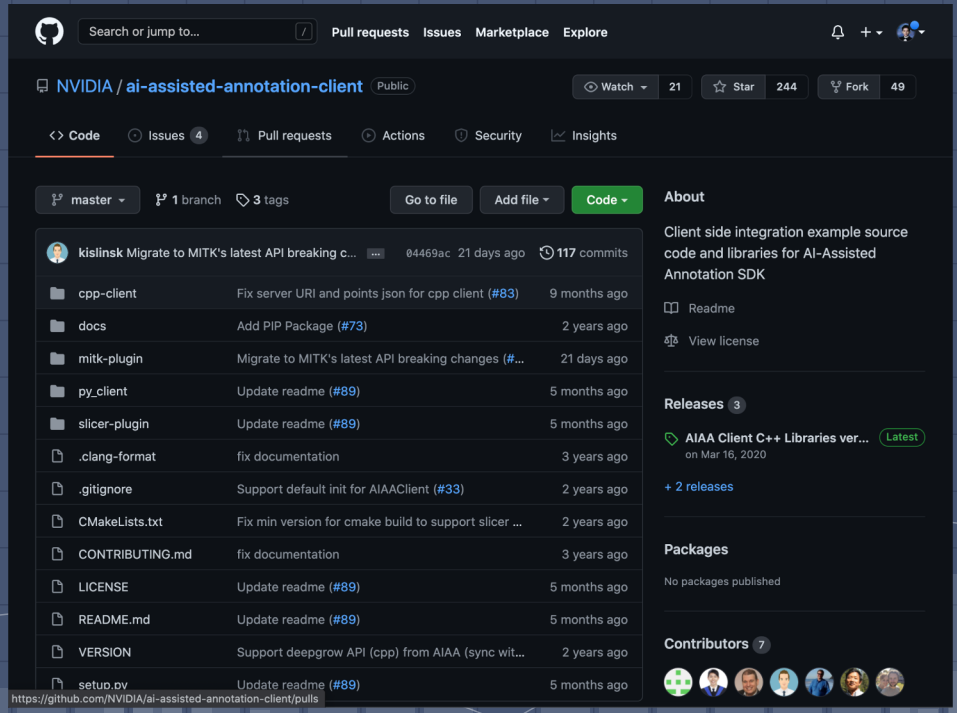
- A framework that enables model training
- Challenges: Requires GPU (Windows-specific)
- Expectations: To be able to train our own pelvic model which will render a better quality 3D model



Current Prospect

Accessing Nvidia AIAA's Github

- Currently trying to implement features without using the user interface
- Meaning, implementing through back-end code!



Current Prospect

Acquiring More Data

- Given the nature of the project, data is very limited
- Finding open data
  - Client (10)
  - The Cancer Imaging Archive (TCIA) (8)
  - Generative Adversarial Networks (GANs algorithm)

Future Direction

1. Priority - **Streamline** imaging analysis process
    a. Gain better understanding Nvidia AIAA and 3D slicer's Github repo
    b. Clara Train SDK

Thank you for listening!