GRACE HOPPER CELEBRATION

ANITA B.ORG

Virtual Reality for Brain Surgeries

Enhancing Visualization + Improving Patient Outcomes

Prachi Shah

PRACHI SHAH

- Software Engineer at Verily (Google Life Sciences)
- Carnegie Mellon MS in Computer Science
- Love working on side projects (like this one!)
- Goal: Unite Health and Computer Science

"to.prachi11@gmail.com"
"linkedin.com/in/shahprachi"

AGENDA

Overview

The Problem

3D Modeling

Virtual Reality

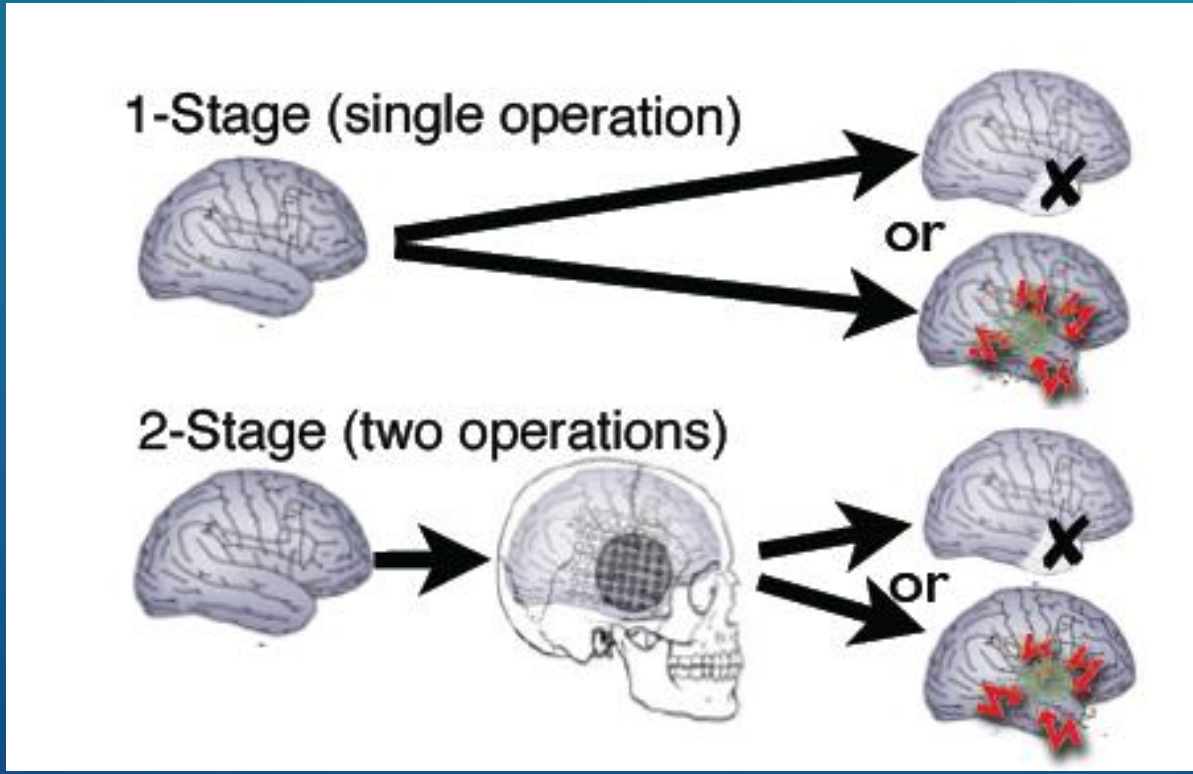
3D Printing

Next Steps

OVERVIEW

- Started with Epilepsy
- Goal: Plan surgeries carefully to resect less of the brain

Epilepsy Surgery requires brain resection. Below are two types of surgery:



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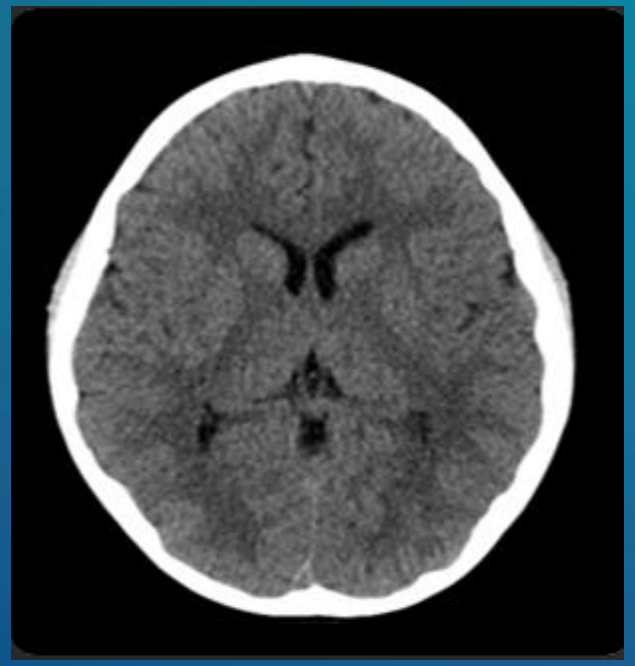
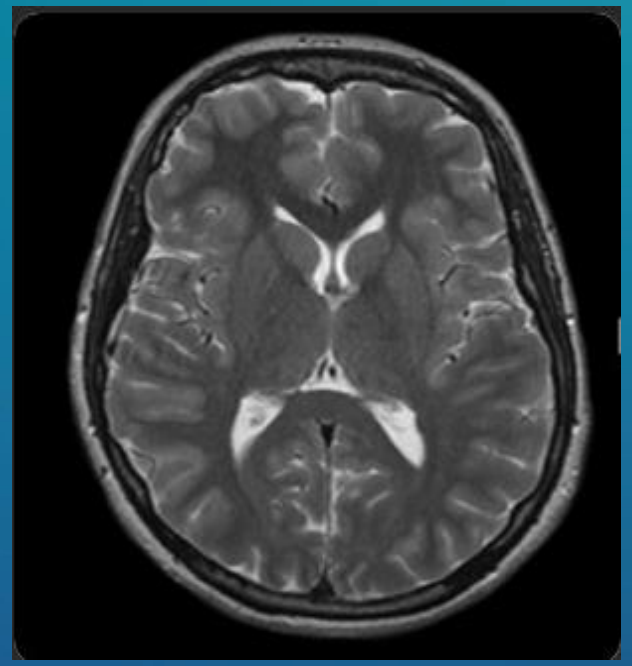
THE PROBLEM

- Current Visualization is Two Dimensional
- The Planning Process isn't Patient Specific

Doctors use two dimensional CT, MRI, PET scans to visualize 3D organs



MRI SCAN

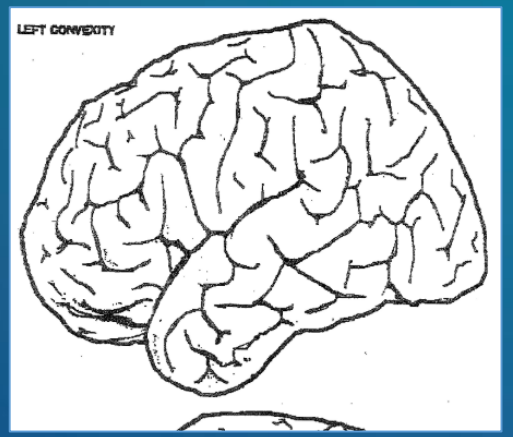


CT SCAN

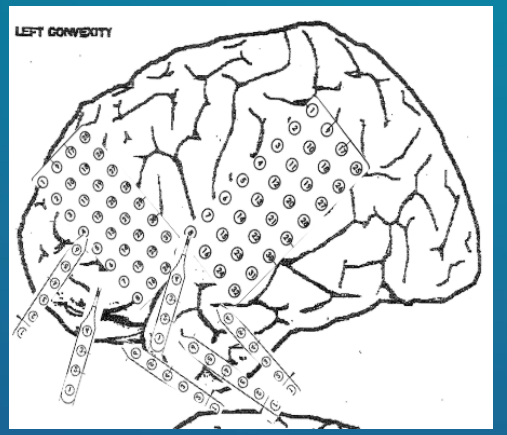
THE PROBLEM

- Current Visualization is Two Dimensional
- The Planning Process isn't Patient Specific

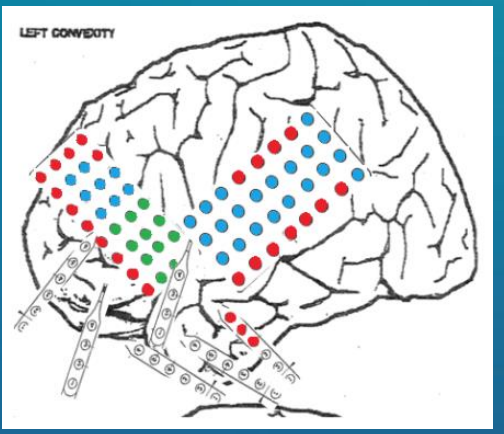
Doctors use the same surgical planning process regardless of medical abnormality or demographic characteristics



STEP 1



STEP 2



STEP 3

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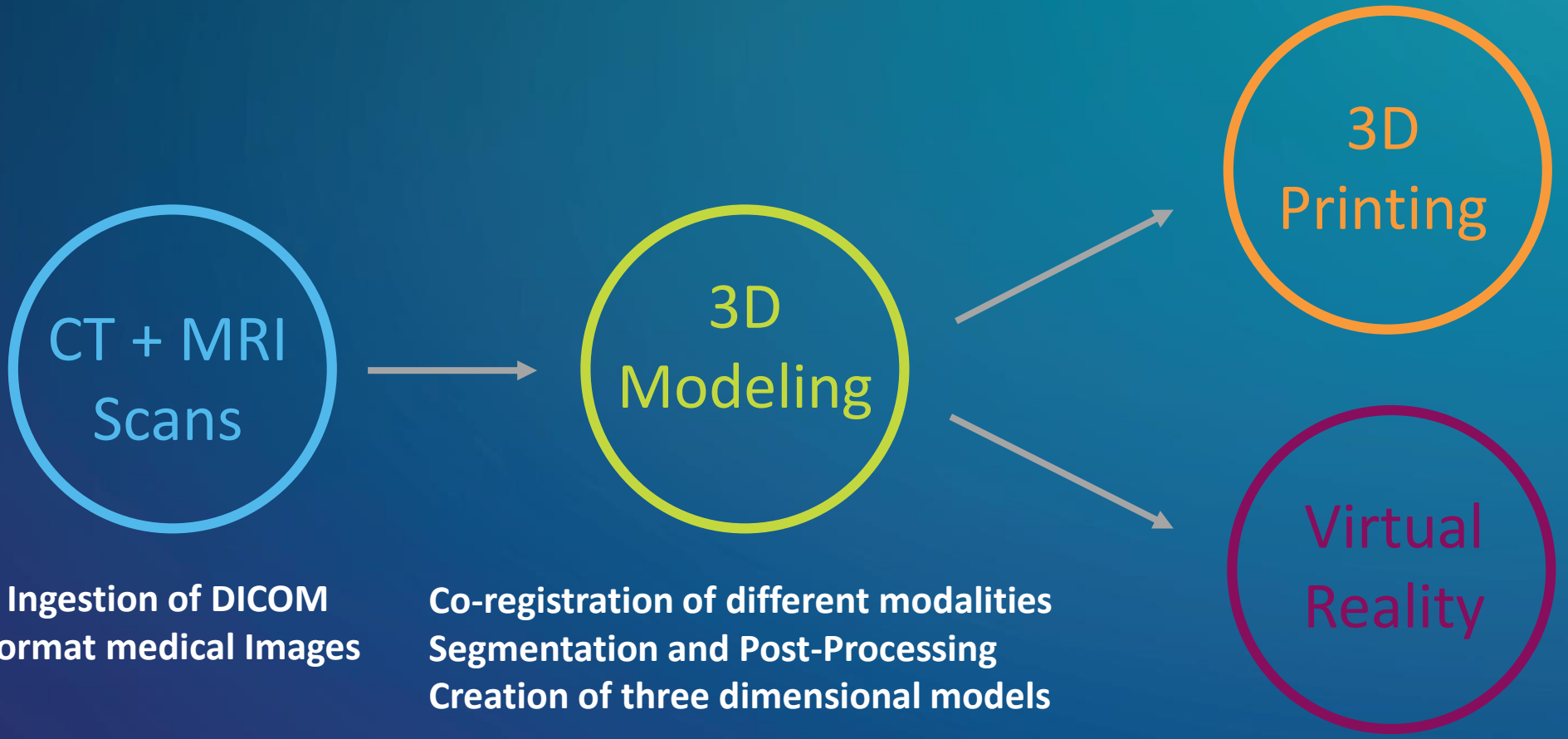
THE SOLUTION



Ingestion of DICOM format medical Images

Co-registration of different modalities
Segmentation and Post-Processing
Creation of three dimensional models

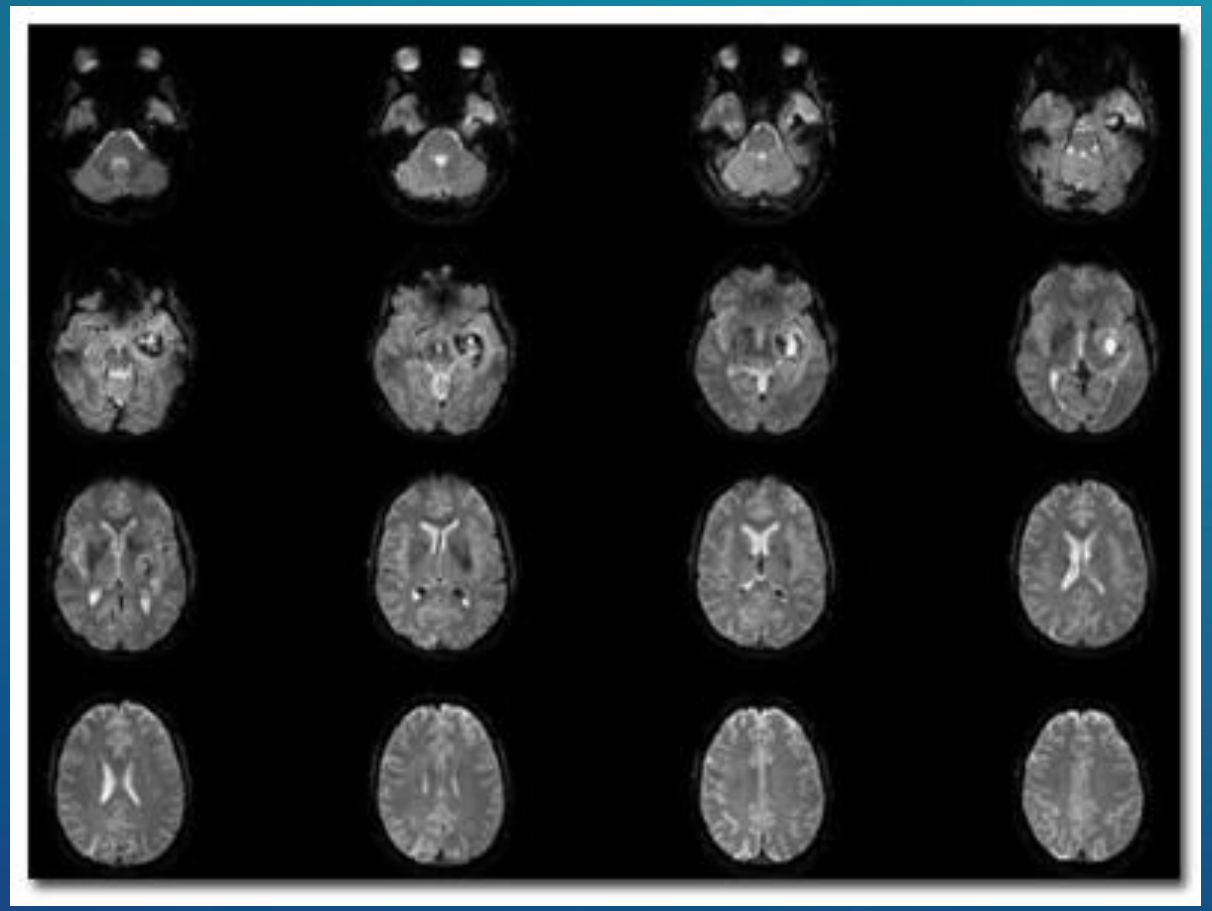
3D printing models of the brain for physical planning + patient education

Visualization in Virtual Reality for software based manipulation of the model

IMAGE INGESTION

- Different Modalities: MRI, CT, PET Scans
- Images are Ingested in DICOM format

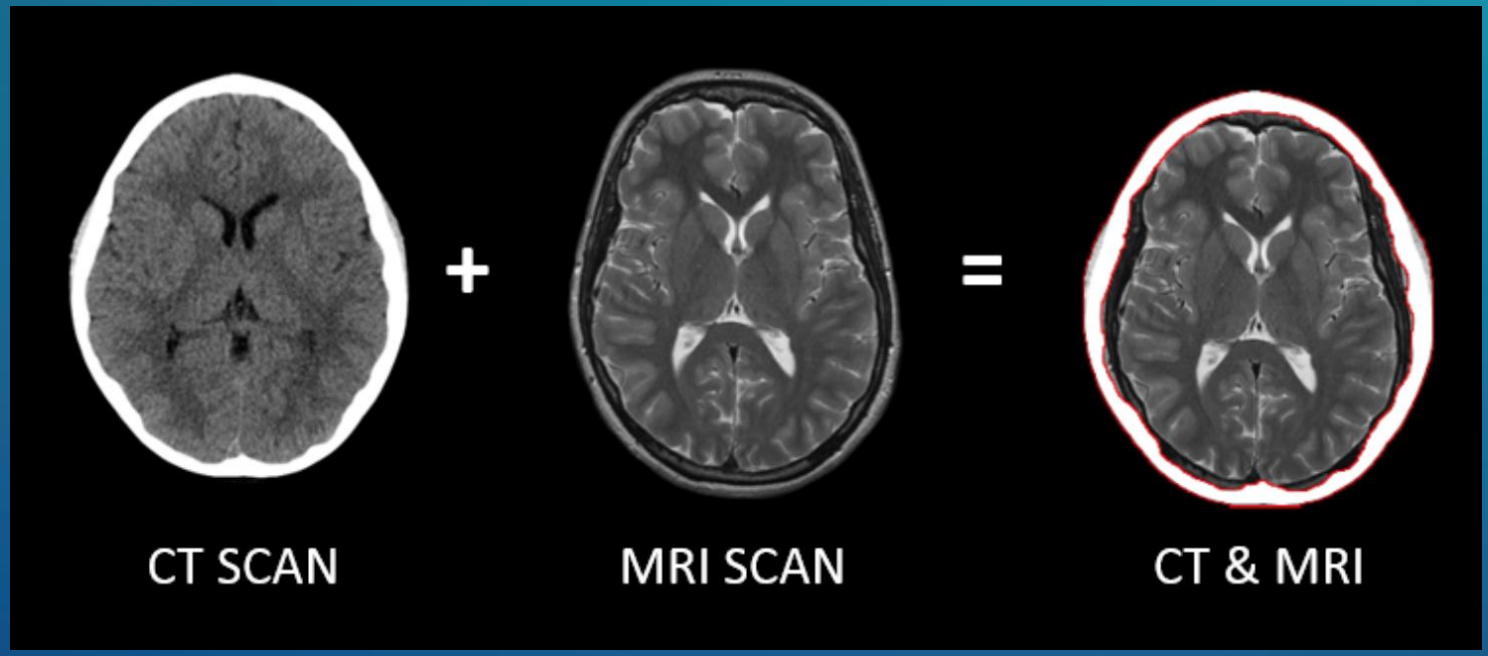
A series of slices (DICOM images) that represent the patient's brain are ingested



CO-REGISTRATION

- Matlab's Statistical Parametric Mapping (SPM) Toolbox
- Account for different image formats, image sizes, pixel to mm ratios, and color schemes

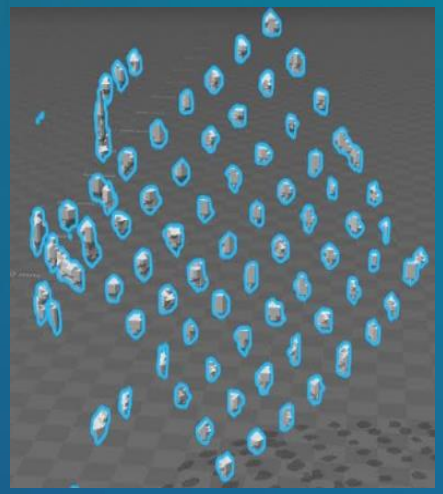
Overlay various modalities with distinct artifacts in the same 3D space



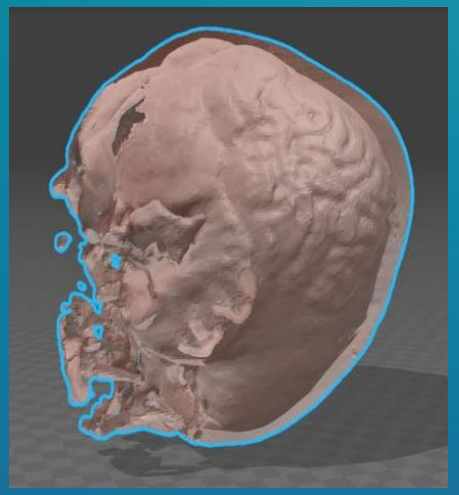
SEGMENTATION

- Separate the 3D brain model in different layers so we can manipulate each one individually

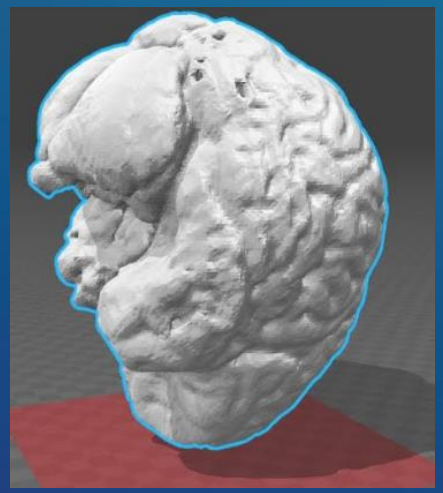
Different layers were segmented from the 3D brain model



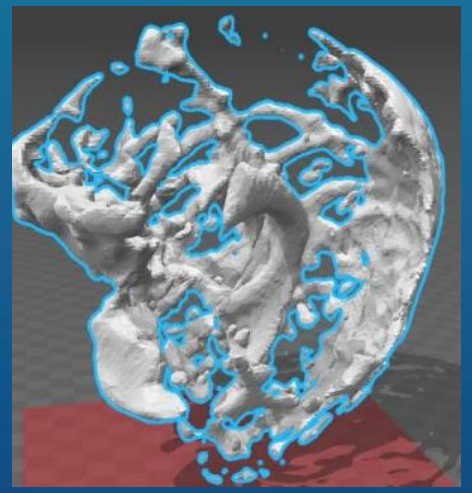
Electrodes



Bone



Gray Matter

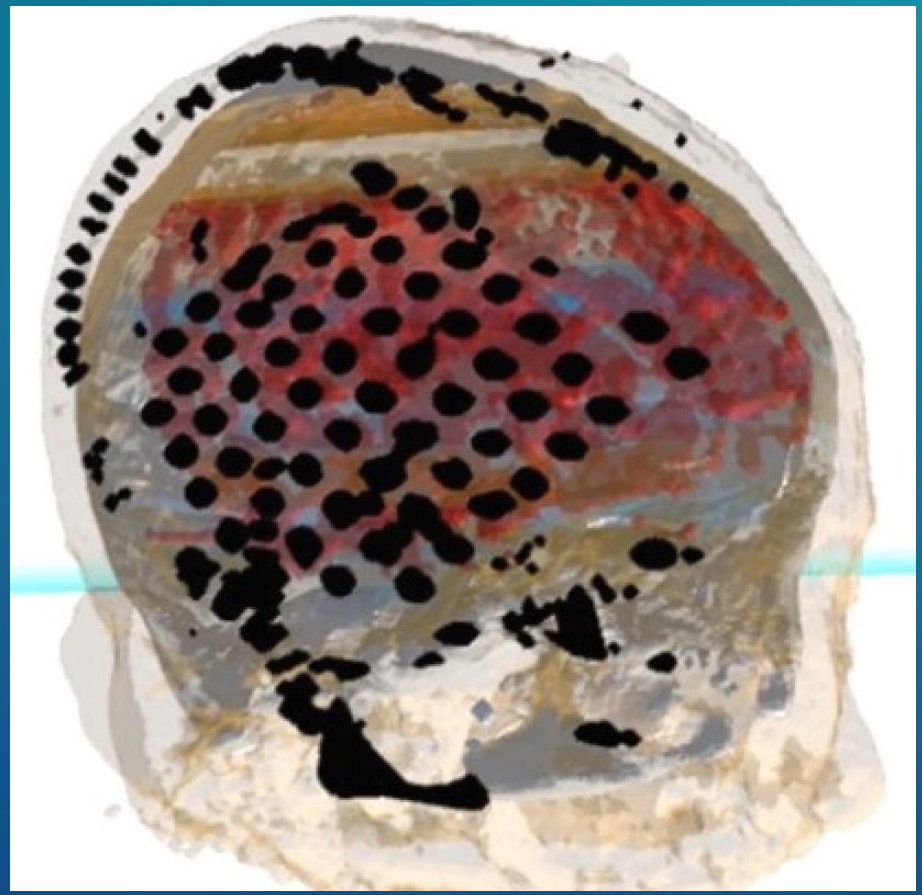


CSP

POST PROCESSING

- Voxel Erosion
- Smoothing Filters
- Save at STL files

Refine 3D structures of the brain as well as remove extra voxels



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Virtual Reality

- Instantaneous Visualization
- In-depth manipulation
- Bring attention to detail
- Promote Collaboration

Neurosurgeon using VR to visualize a patient's brain

HTC Vive: The VR device used to run + test this software

VR Features

- Zoom
- Grip/Move/Rotate
- Toggle Different Layers
- Adjust Transparency
- Slice/Cut

3D model of a real human's brain displayed in Virtual Reality

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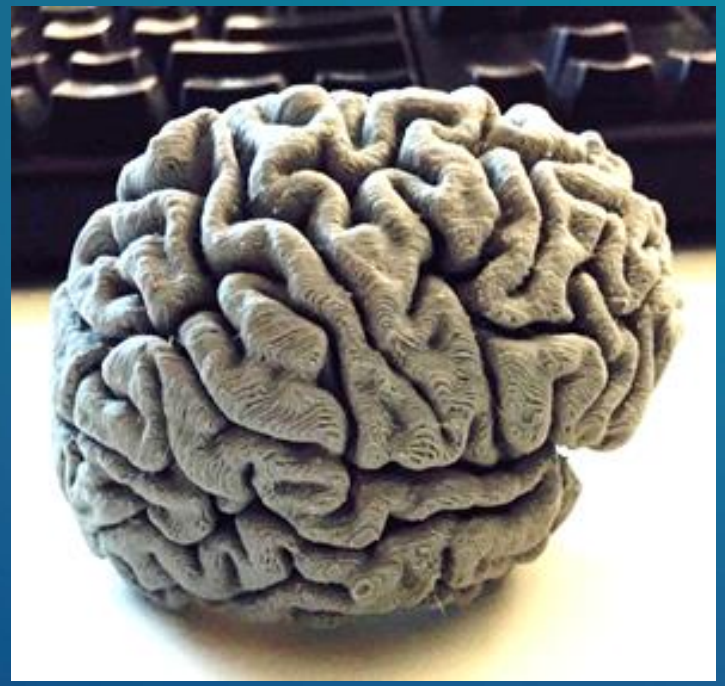
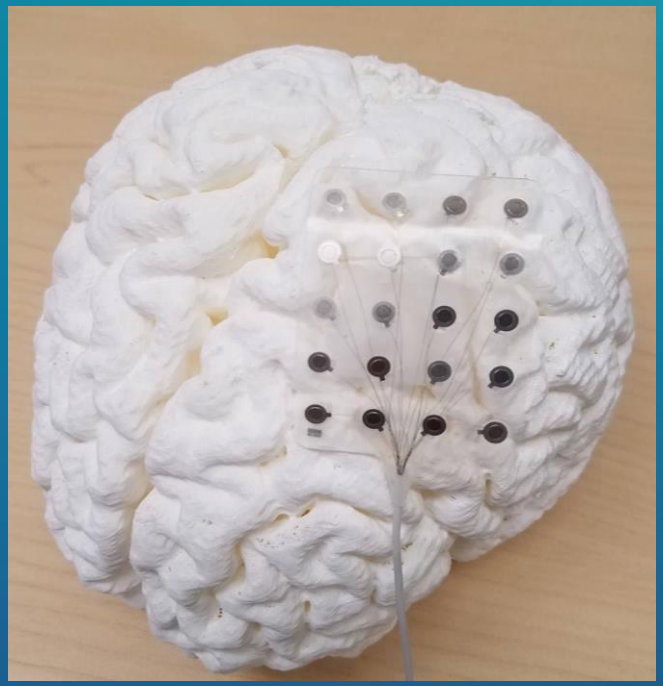
3D Printing

- Life-size Physical Model
- Communication tool
  Educate patients + families
- Use of different materials

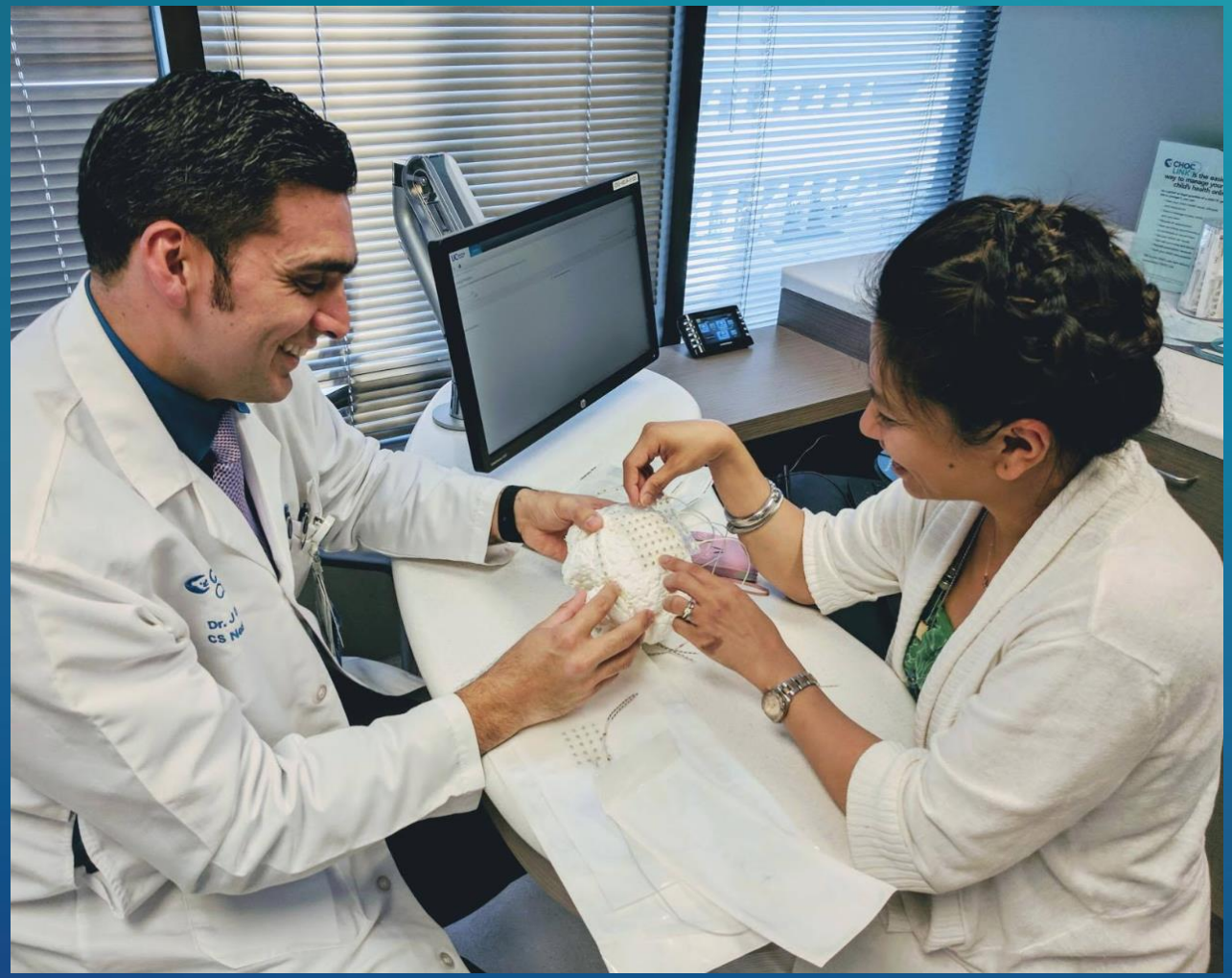
A brain model, 3D printed with PLA, can be utilized to plan brain surgeries





Outcomes

- Deployed Prototypes at local hospitals
- Found changes in surgical strategy were made after using this tool



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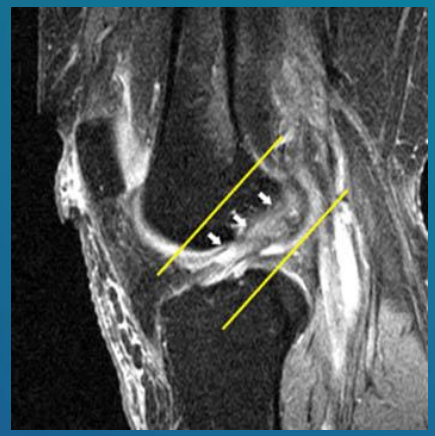
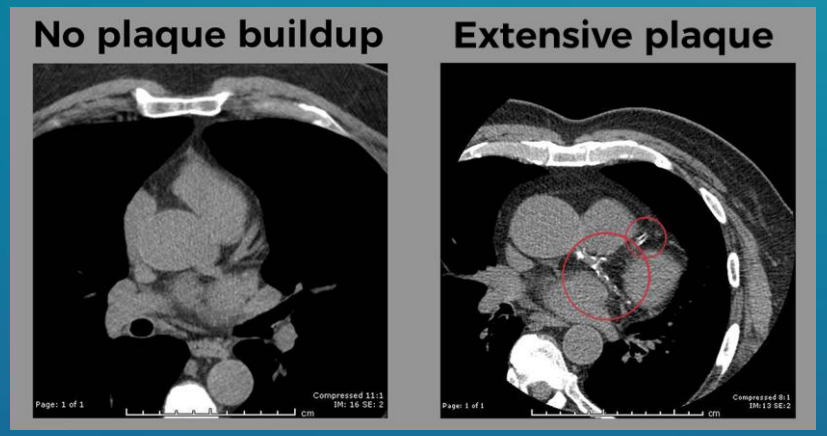
Beyond the Brain

Discovery of
Kidney Stones



Diagnosing ACL tears
+ Monitoring recovery



Determining Plaque Build-up in
the heart

Beyond Surgical Planning

Patient Education

Physician Education

Patient Monitoring

THANK YOU!

Please remember to complete the session survey in the mobile app.

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PRACHI SHAH

"linkedin.com/in/shahprachi"

"to.prachi11@gmail.com"

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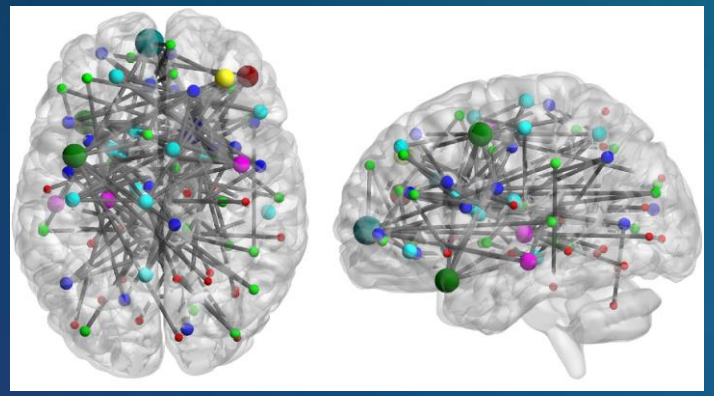
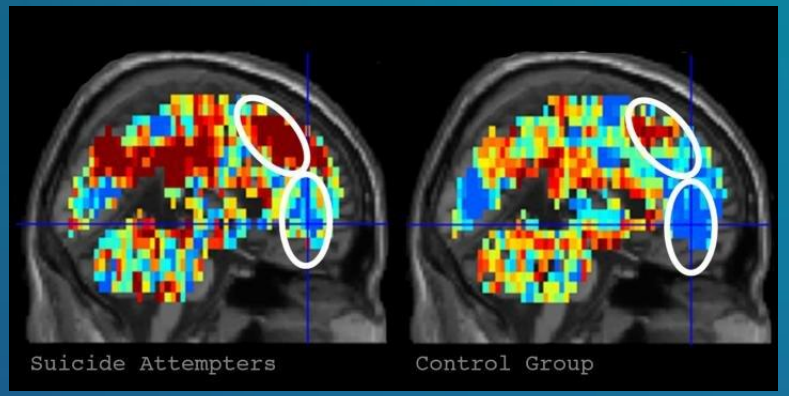
Backup Slides

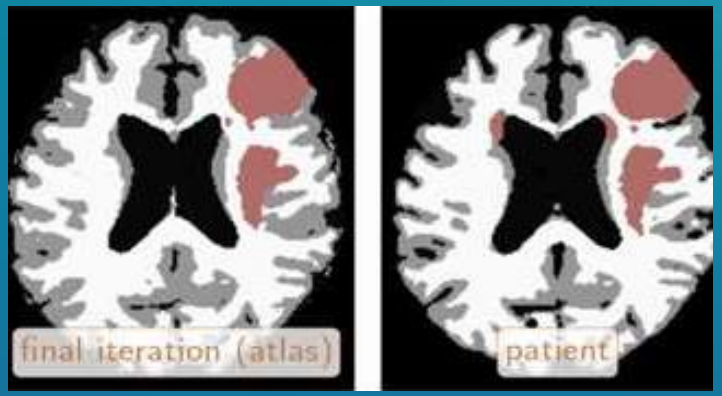
Artificial Intelligence



Statistical machine learning to identify traumatic brain injury (TBI) from structural disconnections of white matter network



Brain Imaging Technology Uses Machine Learning to Identify Suicidal Thoughts



Ability to Identify Brain Tumors Using Machine Learning

Co-registration

The spatial alignment of a series of images, either from intra-subject or inter-subject image volumes.

Different Types

- Landmark based: identify cerebrum borders, map to Talairach template
- Volume based: maximize overlapping voxels
- Surface based: use cortical surface instead of full brain volume

Tool Boxes

- SPM: Statistical Parametric Mapping
- AFNI: Analysis of Functional NeuroImages

Real Time AR/VR

VR in Telemedicine + Surgical Robotics