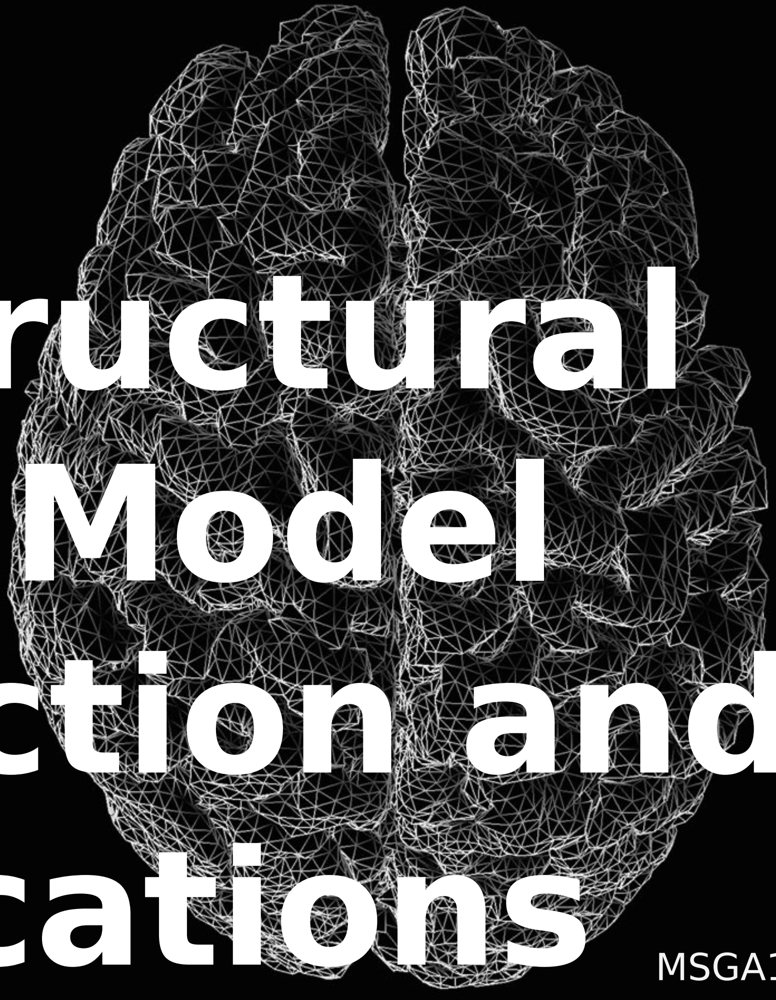
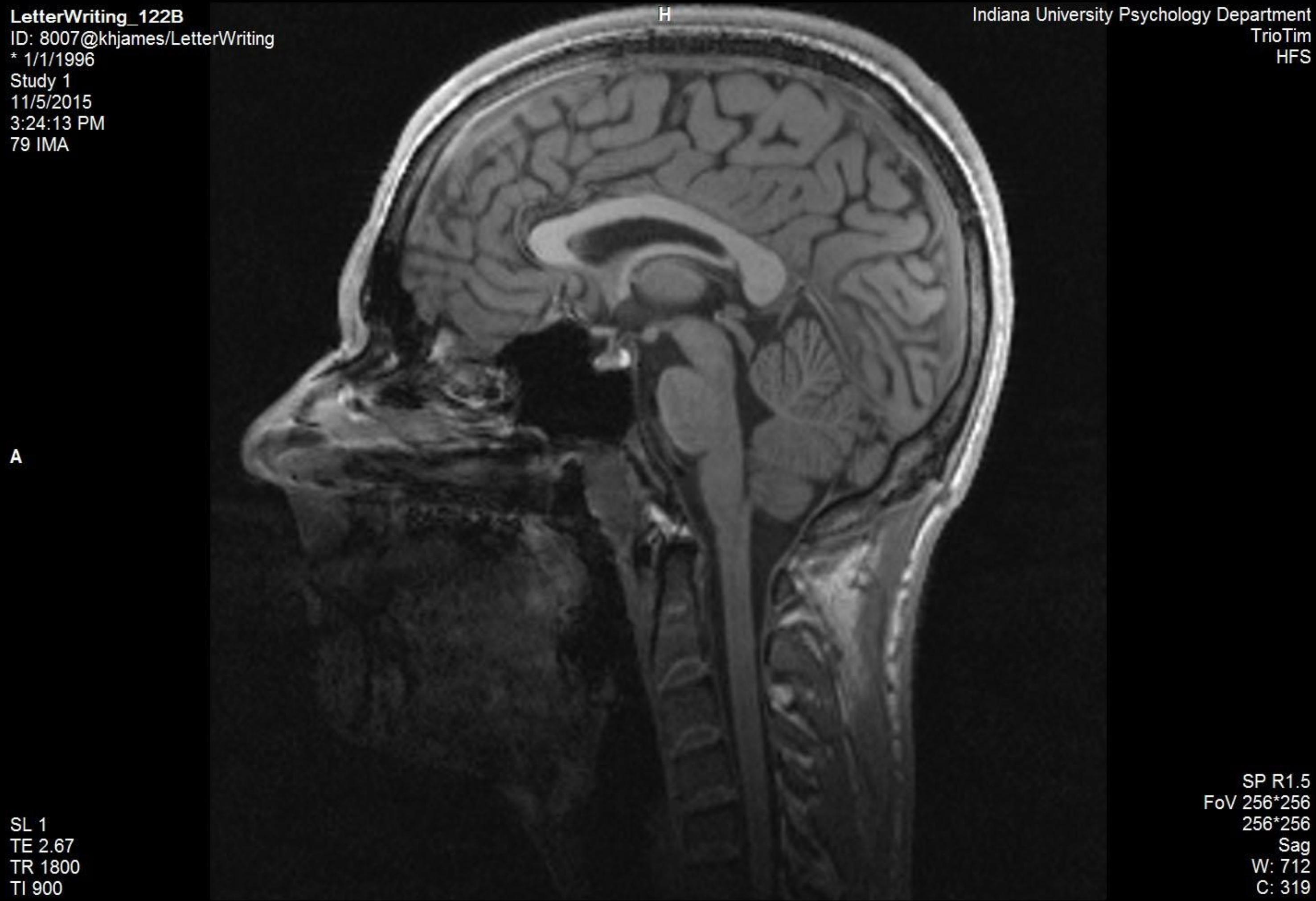


3D Structural Brain Model Extraction and Applications

MSGA18 23 - 02 Keiland W. Cooper


LetterWriting_122B
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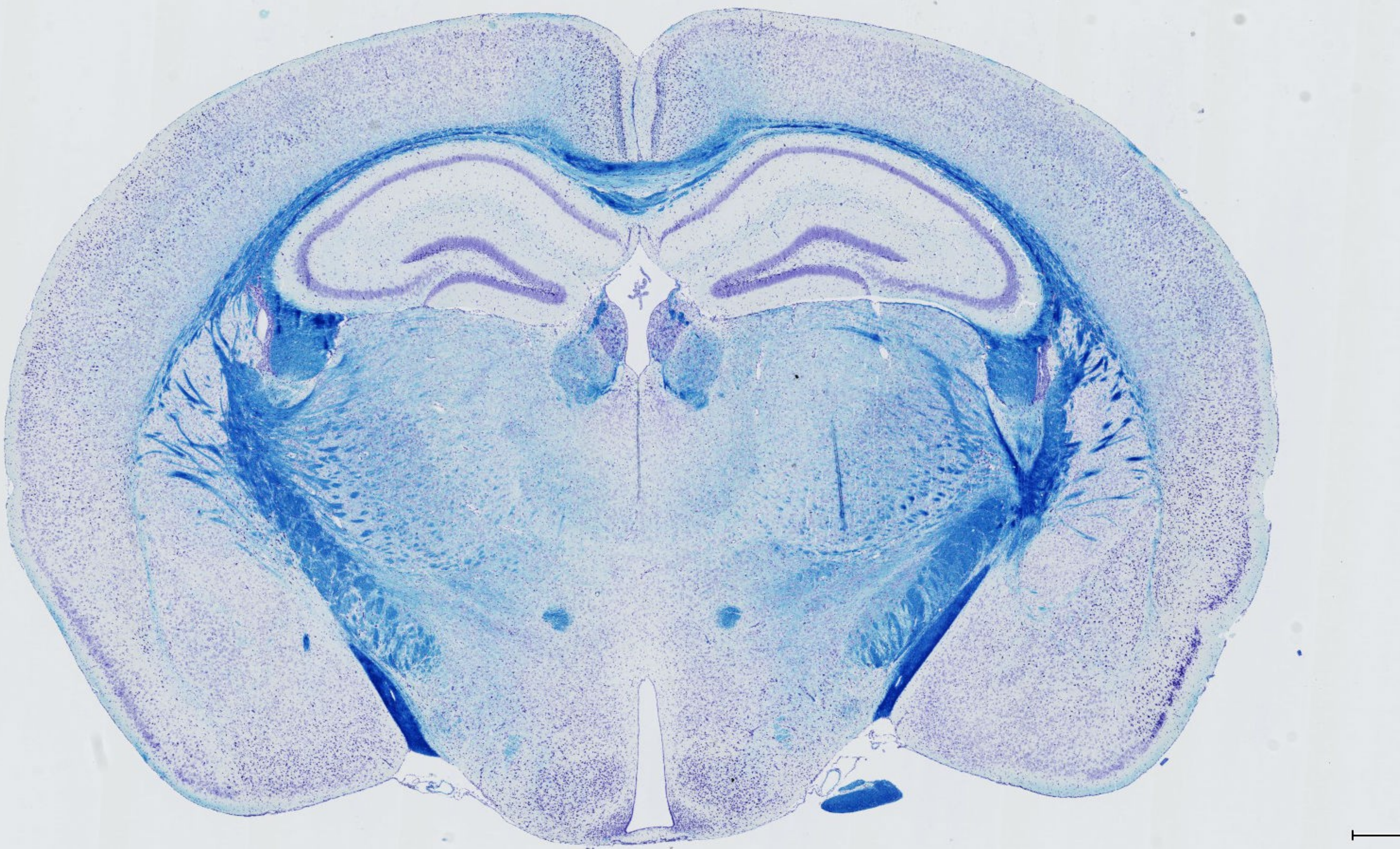
* 1/1/1996
Study 1
11/5/2015
3:24:13 PM
79 IMA
H
Indiana University Psychology Department
TrioTim
HFS
A
SL 1
TE 2.67
TR 1800
TI 900
SP R1.5
FoV 256*256
256*256
Sag
W: 712
C: 319

The brain
is not flat.



Paxinos and Watson's The Rat Brain in Stereotaxic Coordinates 7th Edition

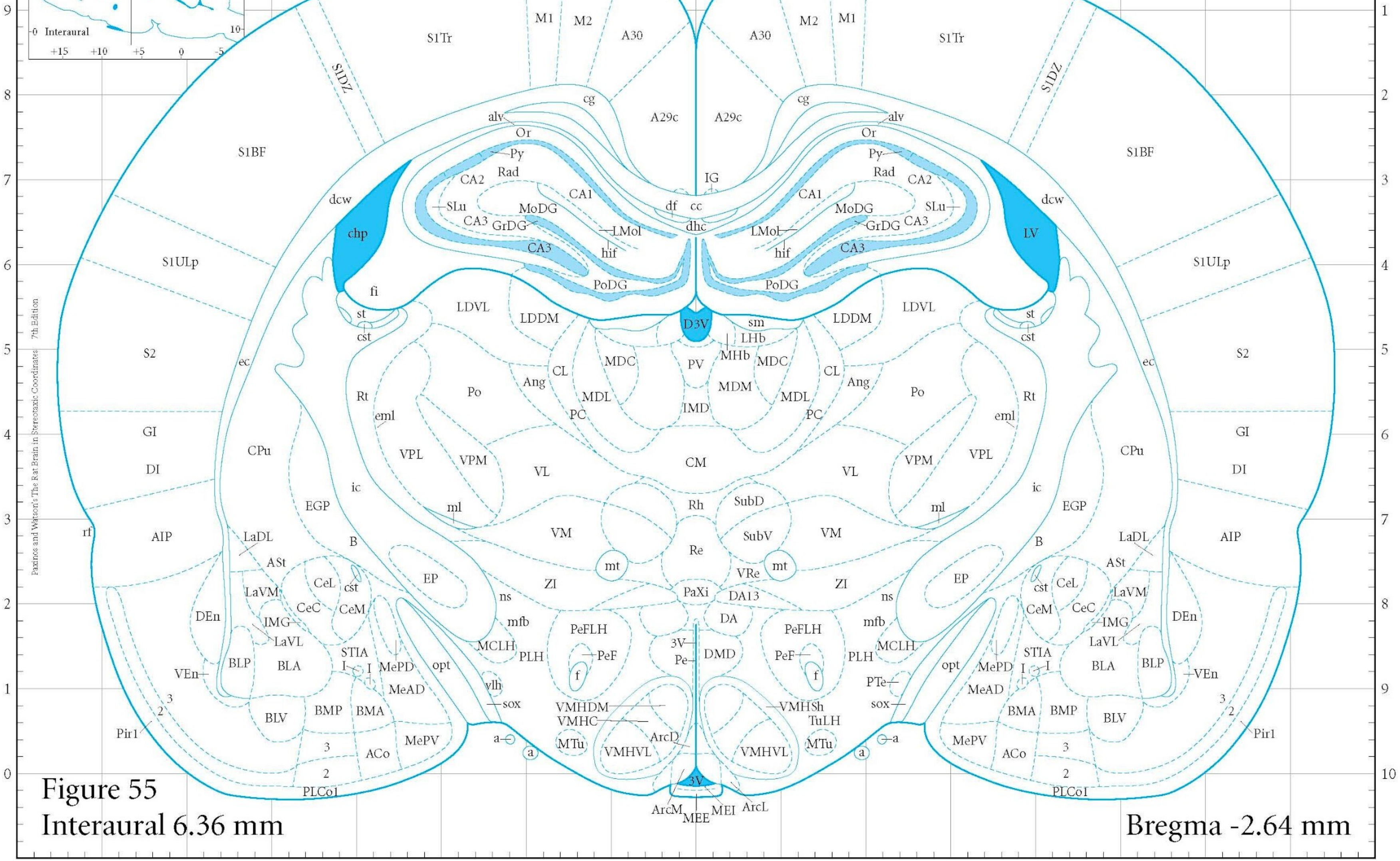
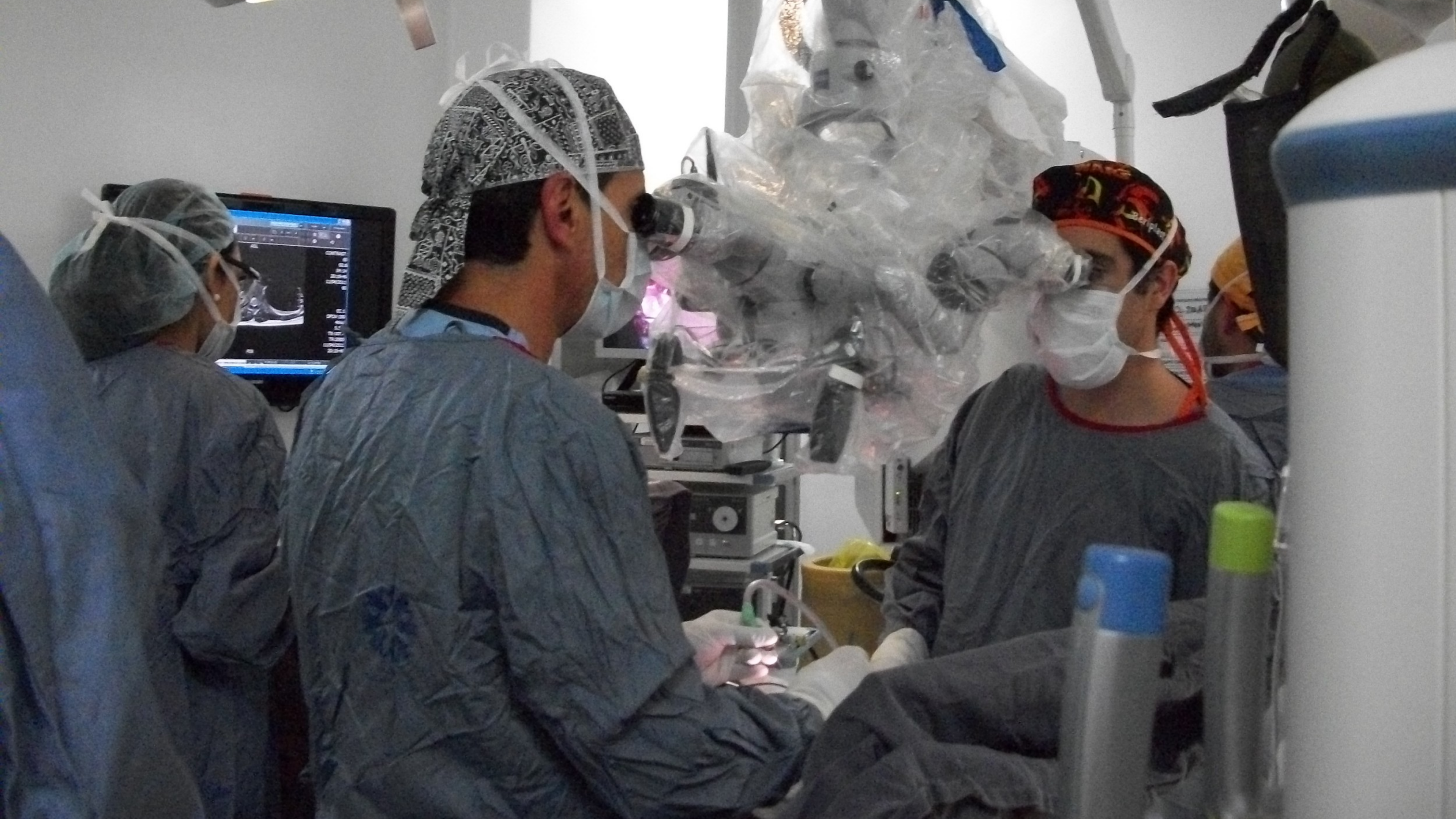
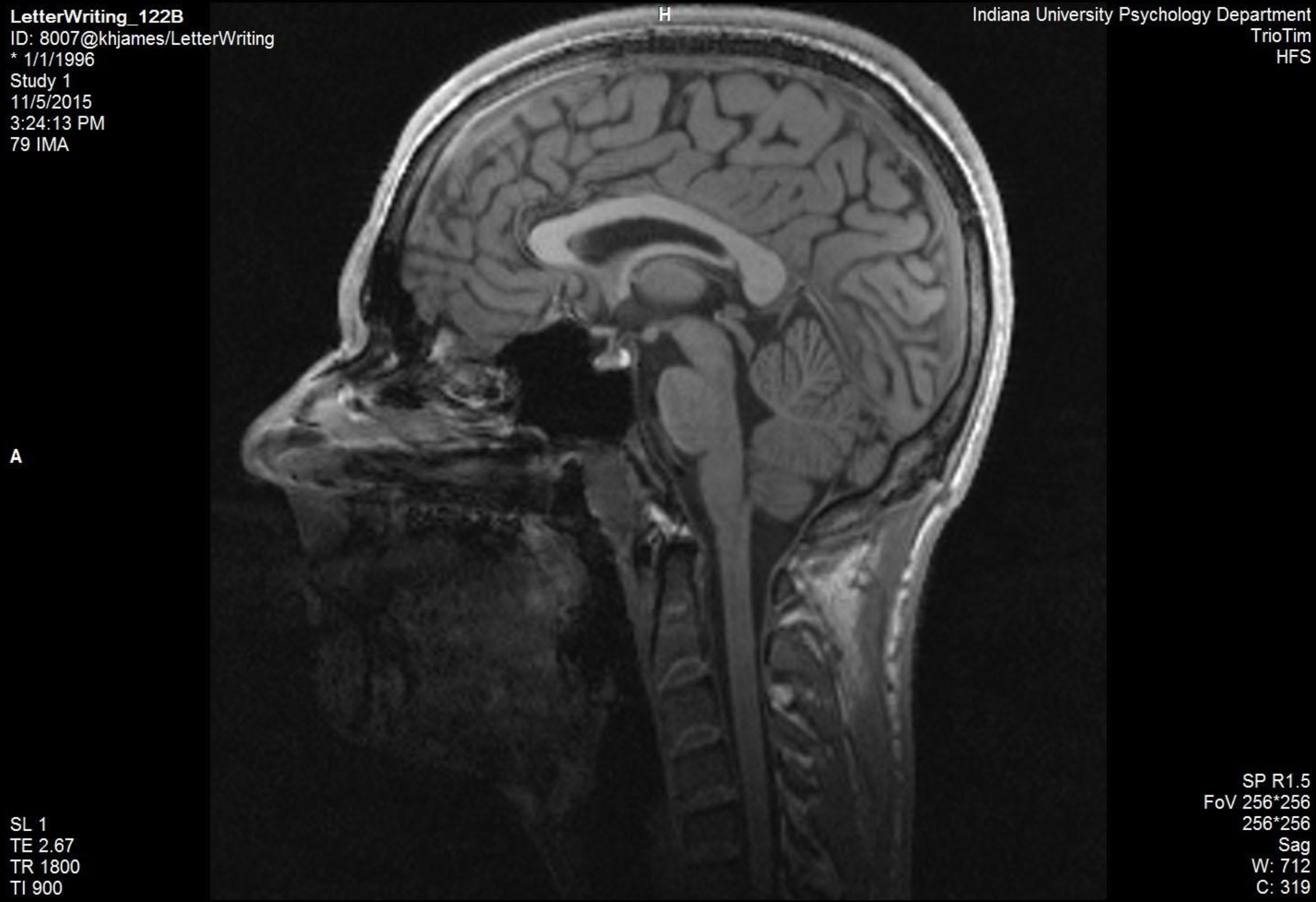


Figure 55
Interaural 6.36 mm

Bregma -2.64 mm

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Sag
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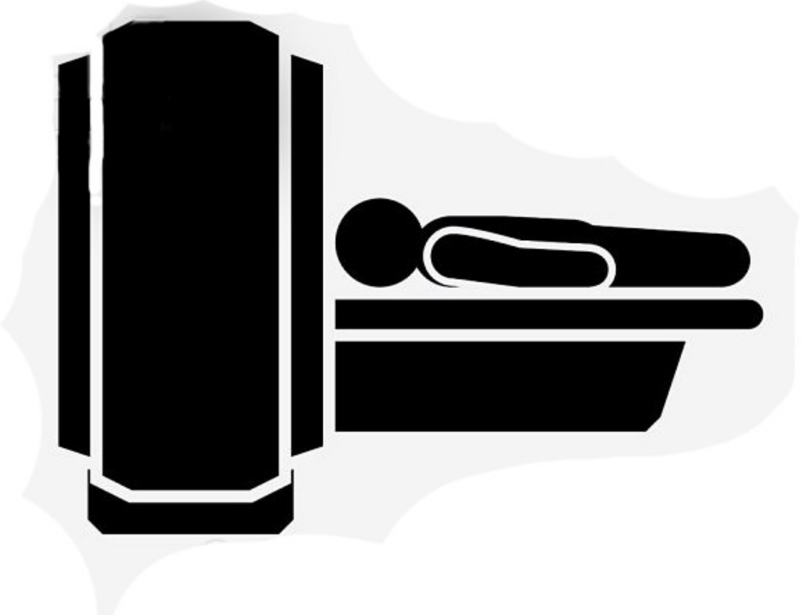
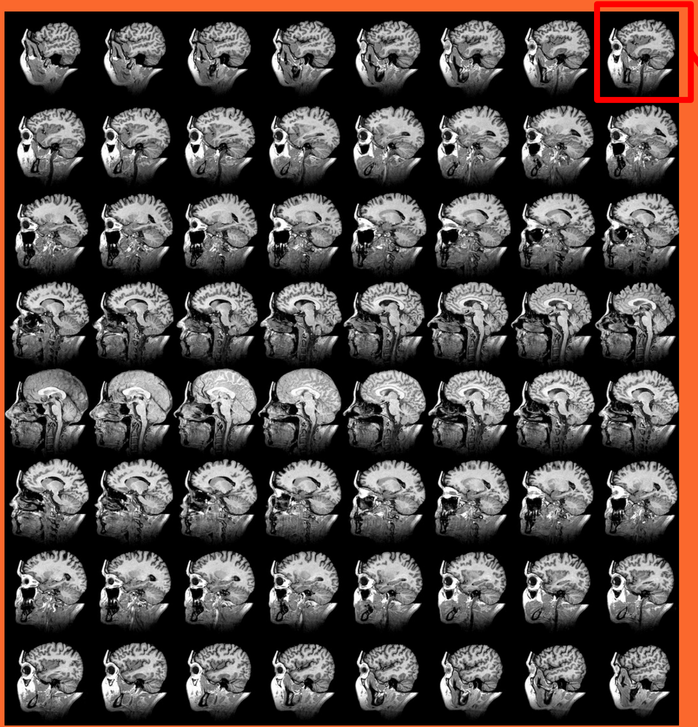
C: 319

fMRI:

a crash course



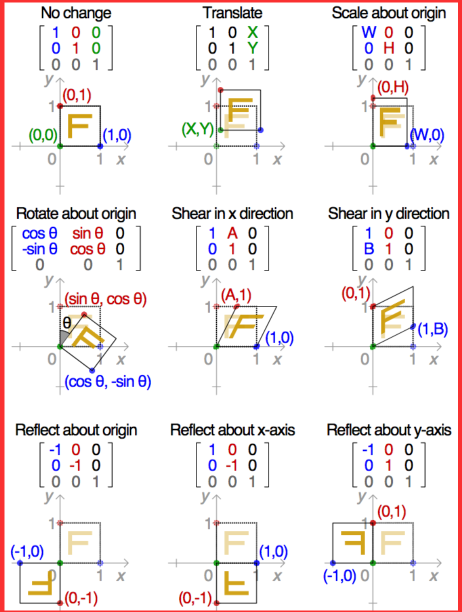


$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1m} \\ a_{21} & a_{22} & \cdots & a_{2m} \\ \cdots & \cdots & \cdots & \cdots \\ a_{n1} & a_{n2} & \cdots & a_{nm} \end{bmatrix}_{n \times m}$$

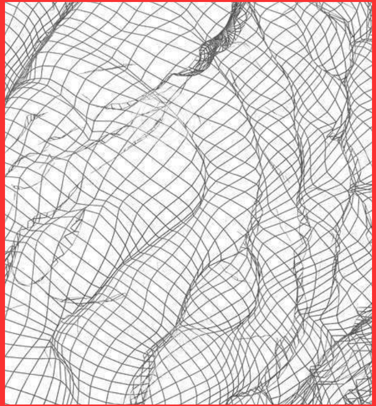
(Stanford volume data archive)

Pipeline

Brain Localization /
Skull stripping



Transformation /
Parameter exploration



Mesh Construction

Pipeline

That is, the prior probability of a label at a given vertex **r** is only influenced by the labels within some neighborhood of **r**. The locality restriction imposed by the Markov model permits the probability of the entire parcellation to be written in terms of neighborhood or *clique* potentials $V_C(P)$ via the Hammersley–Clifford theorem (Besag, 1974). That is, the probability $p(P)$ can be equivalently characterized by a Gibbs distribution:

$$p(P) = \frac{1}{Z} e^{-U(P)} \tag{11}$$

where Z is a normalizing constant and will be dropped in the following, and $U(P)$ is an energy function that can be written in the form:

$$U(P) = \sum_c V_c(P) \tag{12}$$

The clique potentials $V_C(P)$ encode the energy associated with a certain configuration of labels within the cth clique. Choosing $V_C(P)$ to be $-\log(p(P(\mathbf{r})|P(\mathbf{r}_1), P(\mathbf{r}_2) \ldots P(\mathbf{r}_K))$, where **r** is the central vertex of the cth clique, allows us write the probability of the entire parcellation as the product of the probability of the label at each vertex, given its neighborhood:

$$p(P) = \prod_{r \in S} p(P(\mathbf{r})|P(\mathbf{r}_1), P(\mathbf{r}_2), \ldots, P(\mathbf{r}_K)), \ \mathbf{r}_i \in N(\mathbf{r}) \tag{13}$$

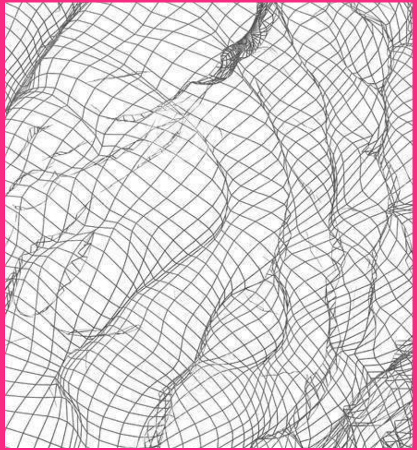
Using Bayes rule, we can rewrite this as:

$$p(P) \propto \prod_{r \in S} p(P(\mathbf{r}))p(P(\mathbf{r}_1), P(\mathbf{r}_2), \ldots, P(\mathbf{r}_K)|P(\mathbf{r})), \ \mathbf{r}_i \in N(\mathbf{r}) \tag{14}$$

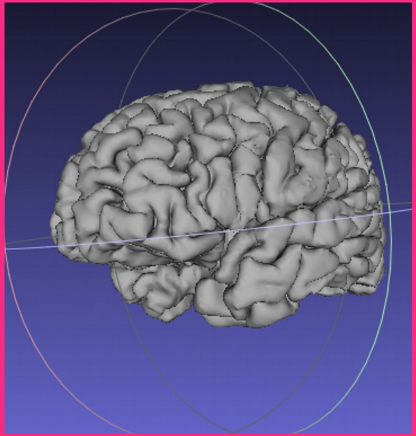
Equation (14) allows the probability of a given label to be modulated by any configuration of neighboring labels. While this would be extremely useful, it is unfortunately not computationally tractable to implement, as one would need to compute separate prior probabilities for every combination of neighboring labels that occur. Instead, we make the simplifying assumption that

(Fischl 2004)

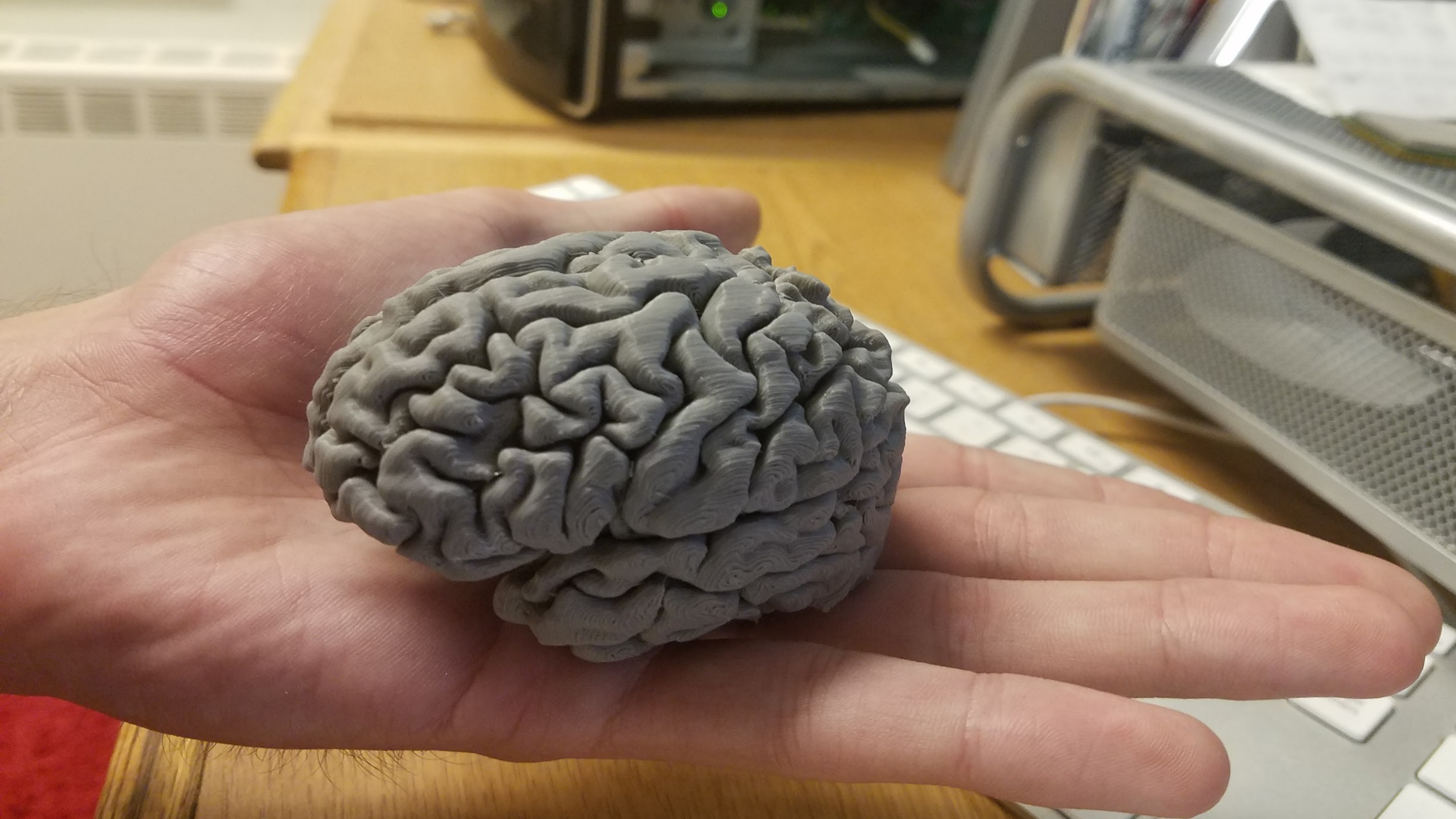
Pipeline

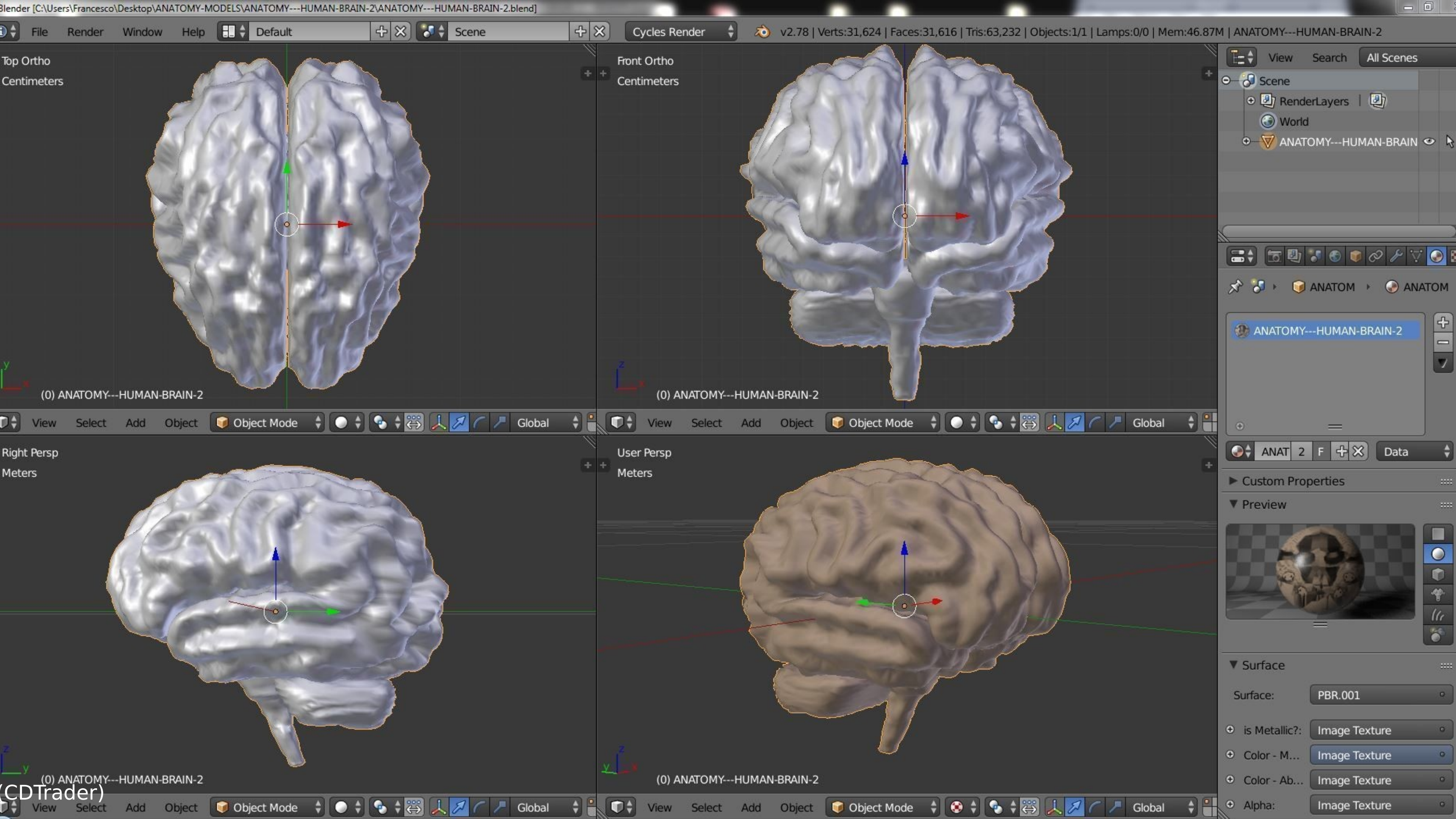


Native File Conversion



Post processing / rendering





Blender [C:\Users\Francesco\Desktop\ANATOMY-MODELS\ANATOMY---HUMAN-BRAIN-2\ANATOMY---HUMAN-BRAIN-2.blend]
File Render Window Help
Default
Scene
Cycles Render
v2.78 | Verts:31,624 | Faces:31,616 | Tris:63,232 | Objects:1/1 | Lamps:0/0 | Mem:46.87M | ANATOMY---HUMAN-BRAIN-2
Top Ortho
Centimeters
(0) ANATOMY---HUMAN-BRAIN-2
Front Ortho
Centimeters
(0) ANATOMY---HUMAN-BRAIN-2
Right Persp
Meters
(0) ANATOMY---HUMAN-BRAIN-2
User Persp
Meters
(0) ANATOMY---HUMAN-BRAIN-2
View Select Add Object Object Mode Global
View Search All Scenes
Scene
RenderLayers
World
ANATOMY---HUMAN-BRAIN
ANATOM ANATOM
ANATOMY---HUMAN-BRAIN-2
ANAT 2 F
Data
Custom Properties
Preview
Surface
Surface: PBR.001
is Metallic?: Image Texture
Color - M... Image Texture
Color - Ab... Image Texture
Alpha: Image Texture
(CDTrader)

(IUSM)

(Huffington Post)

Fischl, Bruce, Liu, Arthur, and Dale, A.M., (2001). Automated Manifold Surgery: Constructing Geometrically Accurate and Topologically Correct Models of the Human Cerebral Cortex. IEEE Transactions on Medical Imaging, 20(1):70-80

Bruce Fischl, Andre van der Kouwe, Christophe Destrieux, Eric Halgren, Florent Segonne, David H. Salat, Evelina Busa, Larry J. Seidman, Jill Goldstein, David Kennedy, Verne Caviness, Nikos Makris, Bruce Rosen, and Anders M. Dale. Automatically Parcellating the Human Cerebral Cortex. Cerebral Cortex January 2004; 14:11-22

Garyfallidis E, Brett M, Amirbekian B, Rokem A, van der Walt S, Descoteaux M, Nimmo-Smith I and Dipy Contributors (2014). Dipy, a library for the analysis of diffusion MRI data. Frontiers in Neuroinformatics, vol.8, no.8.

Ref.

Thank You

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