Computational Anatomy: A tool for analyzing biological change

Computational anatomy brings techniques of mathematical analysis and computer science together with medical data to track anatomical changes.

Goals and Objectives –

Apply computational anatomy tools to:

• Segment brain image data: classify data obtained from MRI scans into three tissue-type components consisting of white matter, gray matter, and cerebrospinal fluid (Fig.1)

• Reconstruct cortical surfaces of the gray/white matter boundary from MRI data using the gray/white threshold value obtained from automated segmentation (Fig. 2)

• Create quasi-conformal (angle preserving) cortical flat maps of the reconstructed brain surface: apply a novel and powerful method to create 2-D surface representations of the brain in order to help delineate anatomical boundaries (Fig. 3)

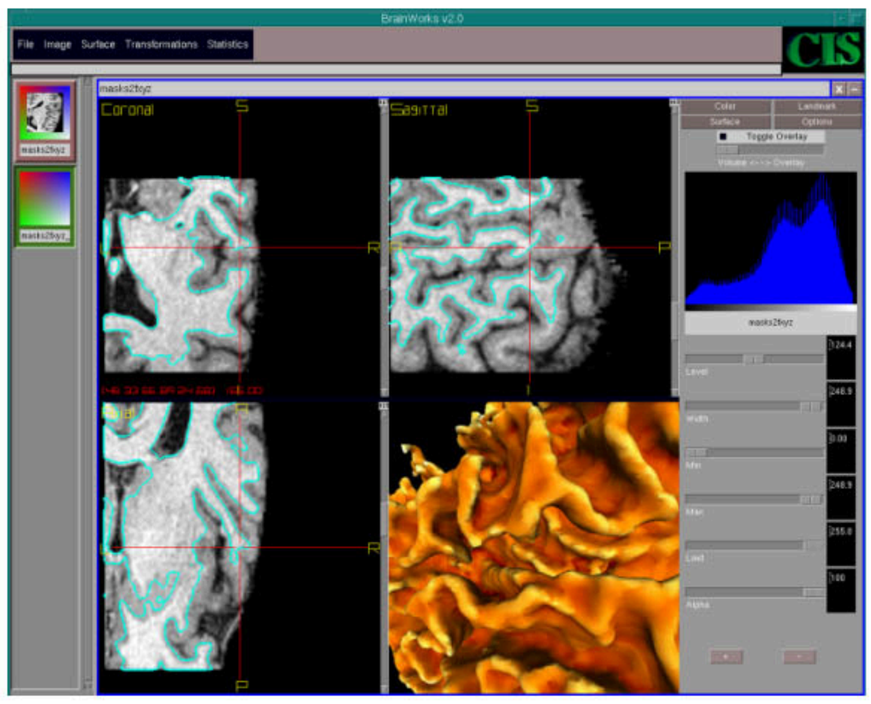

Fig. 1 Orthogonal views of a brain (sagittal, coronal, axial and surface views)

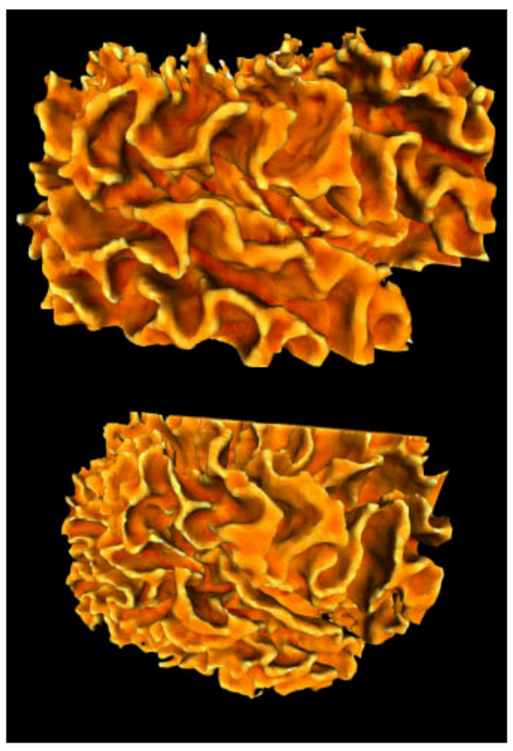

Fig. 2 Surface reconstruction of normal (top) and schizophrenic (bottom) brains

Student Outcomes –

• Familiarization with data acquisition technologies (MRI, fMRI, PET, CAT) and what the major differences are between them

• Understand the nature of the raw data that represents an MRI scan

• Overview of the computer infrastructure and protocols used to send the data to centers around the world for further analysis

• Awareness of mathematical techniques used to analyze biological data

• Awareness of computer programming techniques used to implement mathematical algorithms

• Comparison of historic analysis (manual methods) vs. automated methods (90% accurate segmentation and surface reconstruction)

Discussion –

• The superior temporal gyrus (STG) is implicated in a variety of neuropsychiatric diseases including schizophrenia

• The planum temporale is a special region of the STG that is important in language processing, speech processing and music perception

• Flat maps can help to define boundaries of the planum temporale, particularly in diseased brains

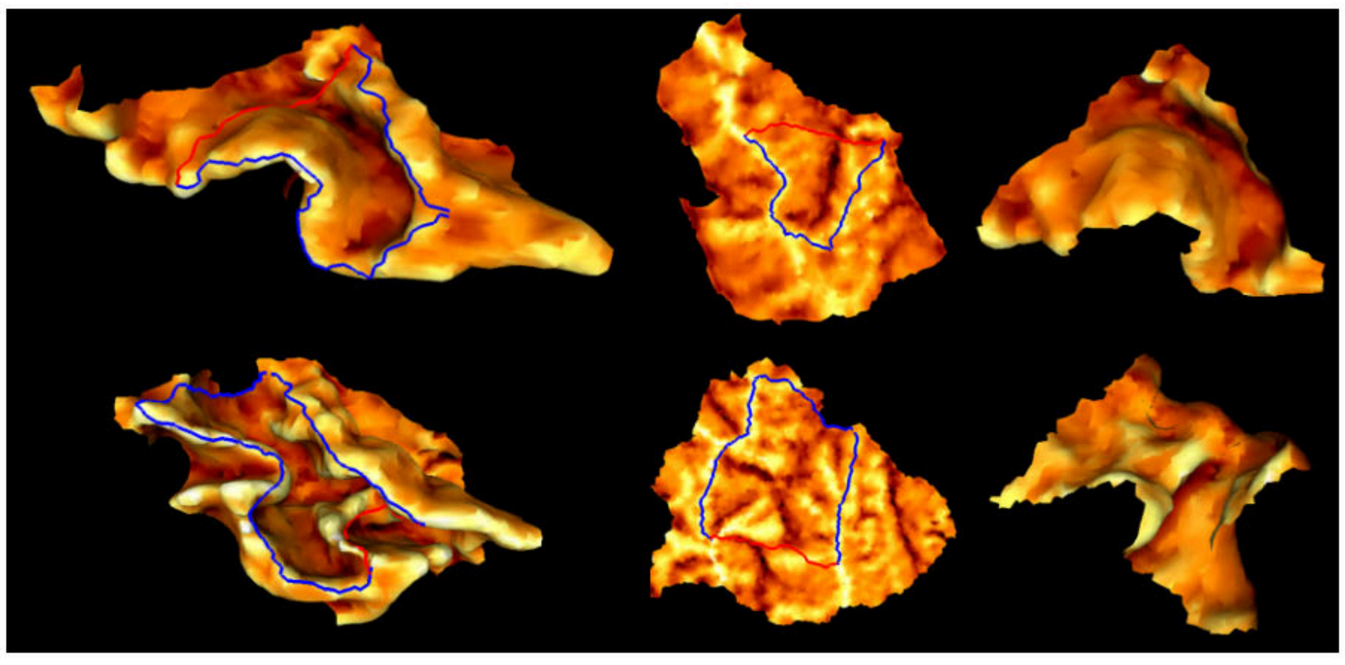

Fig. 3 Flat mapping was successfully used in identifying anatomical boundaries of the planum temporale (PT). Top row: normal STG (left), flattened STG (middle), extracted PT (right); Bottom row: schizophrenic STG (left), flattened (middle), extracted PT (right). Gyral and sulcal curves are indicated in red and blue.

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