# Medical Image Analysis and Processing

Medical Image Registration

Introduction

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#### **Contents**

- > Imaging Modalities
- > Data Integration
- > Image Registration
- > Image Fusion
- > Definition
- > Application

# **Imaging Modalities**

> A: X-Ray image

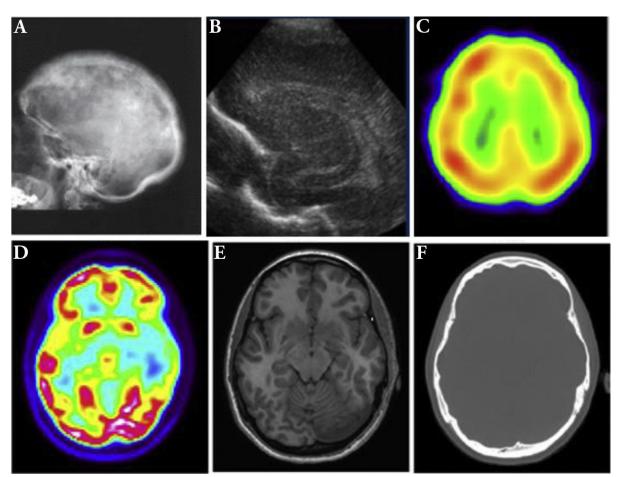
> B: US

> C: SPECT

> D: PET

> E: MRI

> F: CT



# Two Main Categories

- > Structural:
  - -Anatomy and Morphology



- > Functional:
  - -Metabolism and Physiology

### Stuructural Image

- > Show geometry distribution of certain physical properties:
- > Exmaples:
  - -X-Ray and DSA
  - -CT and CTA
  - -MRI and MRA
  - -US
  - -Video (X-Scopy)

# **Functional Imaging**

- > Show functional activity of human organs
- > Examples:
  - -Gamma Camera
  - -SPECT
  - -PET
  - -Brain Mapping (EEG/MEG)
  - -fMRI
  - -fCT

# Medical Image Integration Importance

- >Too many data:
  - Limitation of conventional Diagnosis (hardcopy)
- > Data Dependency:
  - -Multiple information from a single slice
- > Physical Requirements:
  - -Stereotactic surgery (Physical frames)

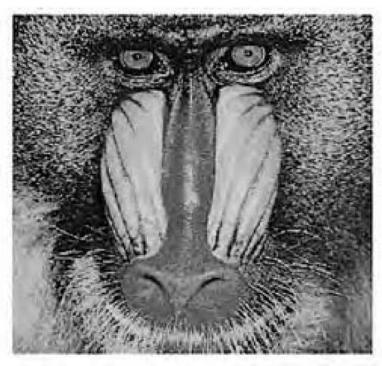
# Final Goal: Data Integration

- > Registration
  - > Bring the modalities involved into spatial alignment
- > Fusion:
  - > Integrated display of the data involved
- > Vocabulary:
  - > Registration
  - > Warping
  - > Co-Registration
  - > Matching
  - > Alignment
  - > Normalization.

# Registration Example (1)

#### > Human-Baboon Face:

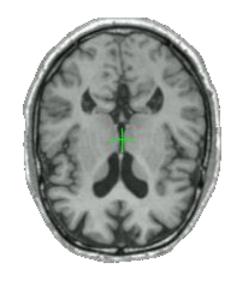


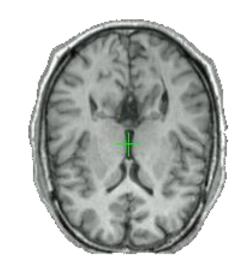


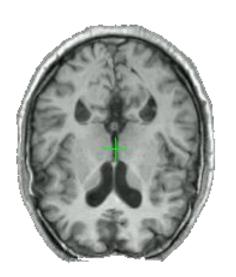


# Registration – Example (2)

> MRI-MRI registration







# Registration – Example (2)

#### > Statistical Atlas

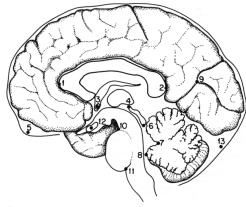


Figure 1. Thirteen landmarks on a schematic midsagitfal MRI. They are named in the text.

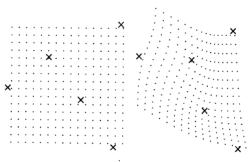
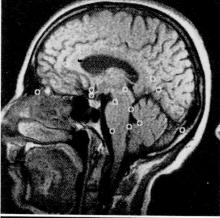


Figure 3. A single shape change of five landmarks and its interpolation by thin-plate spline. The mapping is abown D'Arry-Thompson-style, as it deforms a square grid on the left into the exact interpolant of minimum integrated quadratic variation on the right.





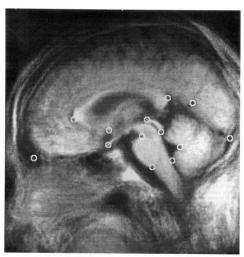
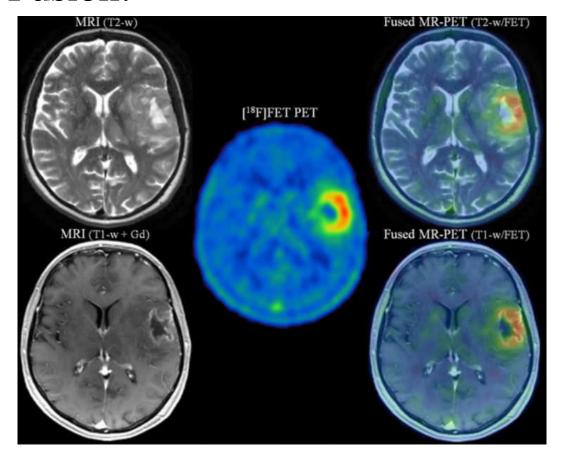


Figure 8. A "midsagittal MRI atlas": the pixelwise average of nine images like that of Figure 7. The text argues that atlases are more appropriately taken as such images than as images or tracings of any single form, however "typical." From Bookstein and Jaynes (1990).

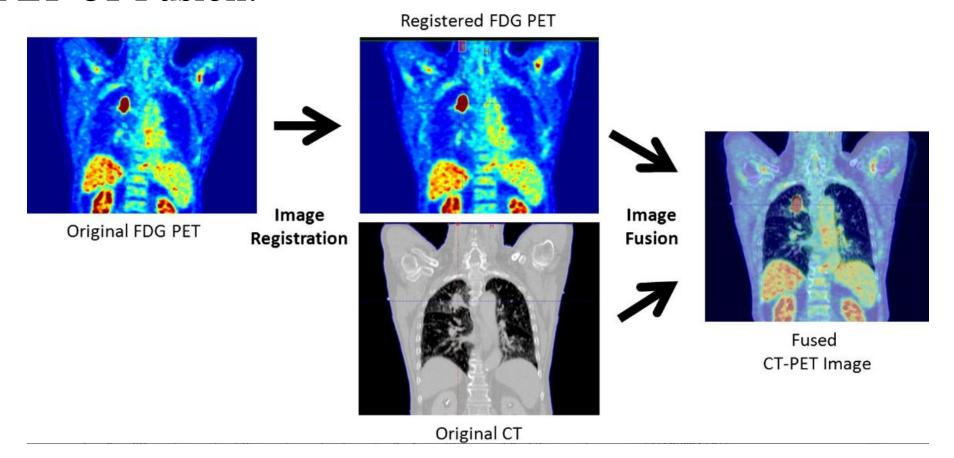
# Fusion – Example (1)

#### > MRI-PET Fusion:



# Fusion – Example (2)

#### > PET-CT Fusion:



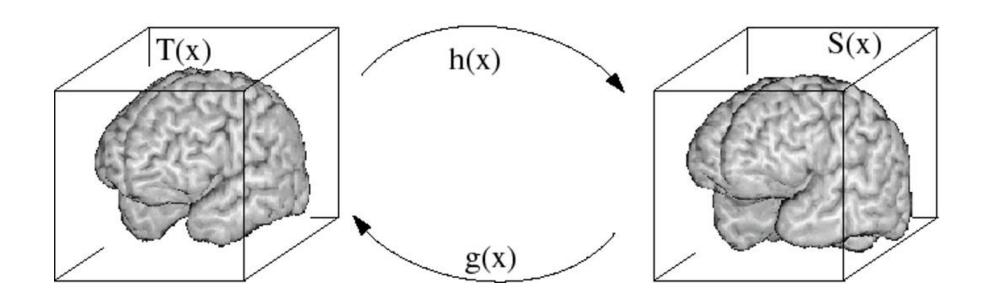
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### Definition

- > A *Transform* (Mathematical mapping) which relates position of *correspondence* structures in two images.
- > Correspondence:
  - -Exact: point by point.
  - -Non-Exact: structure by structure
- >Two Images:
  - -Source-Destination
  - -Head-Hat
  - -Source-Target
  - -Fixed-Float

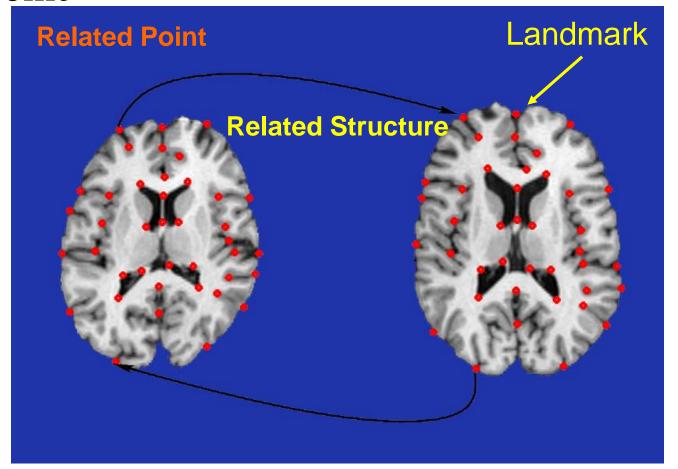
### Illustration

### > Mathematical Mapping



# Correspondence (1)

> Point-to-Point

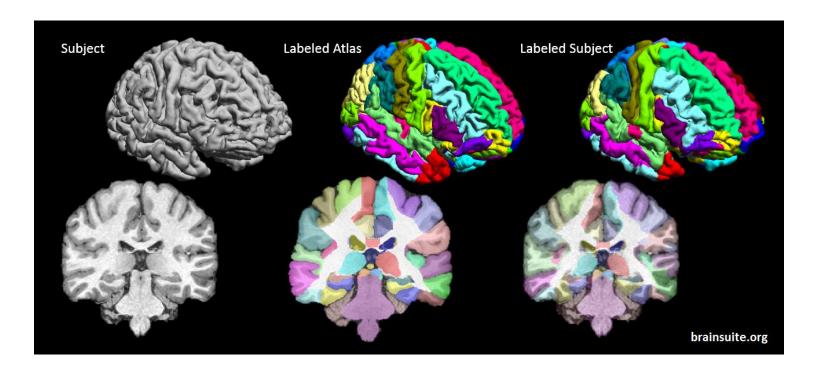


## Application

- > Multi-Modality Fusion
- > Image Segmentation Deformable atlas
- > Population modeling and statistical atlases
- > Characterization of normal vs. abnormal (shape variation)
- > Longitudinal studies
- > Surgical planning and evaluation
- > Image guided surgery
- > Pre-surgical Simulation
- > Other field (GIS and etc.)

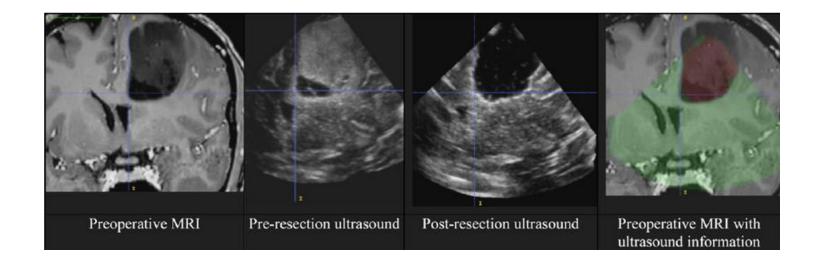
# Segmentation Example

>Atlas-based Segmentation



## Segmentation Example

> Multimodality Fusion



## The End

>AnY QuEsTiOn?

