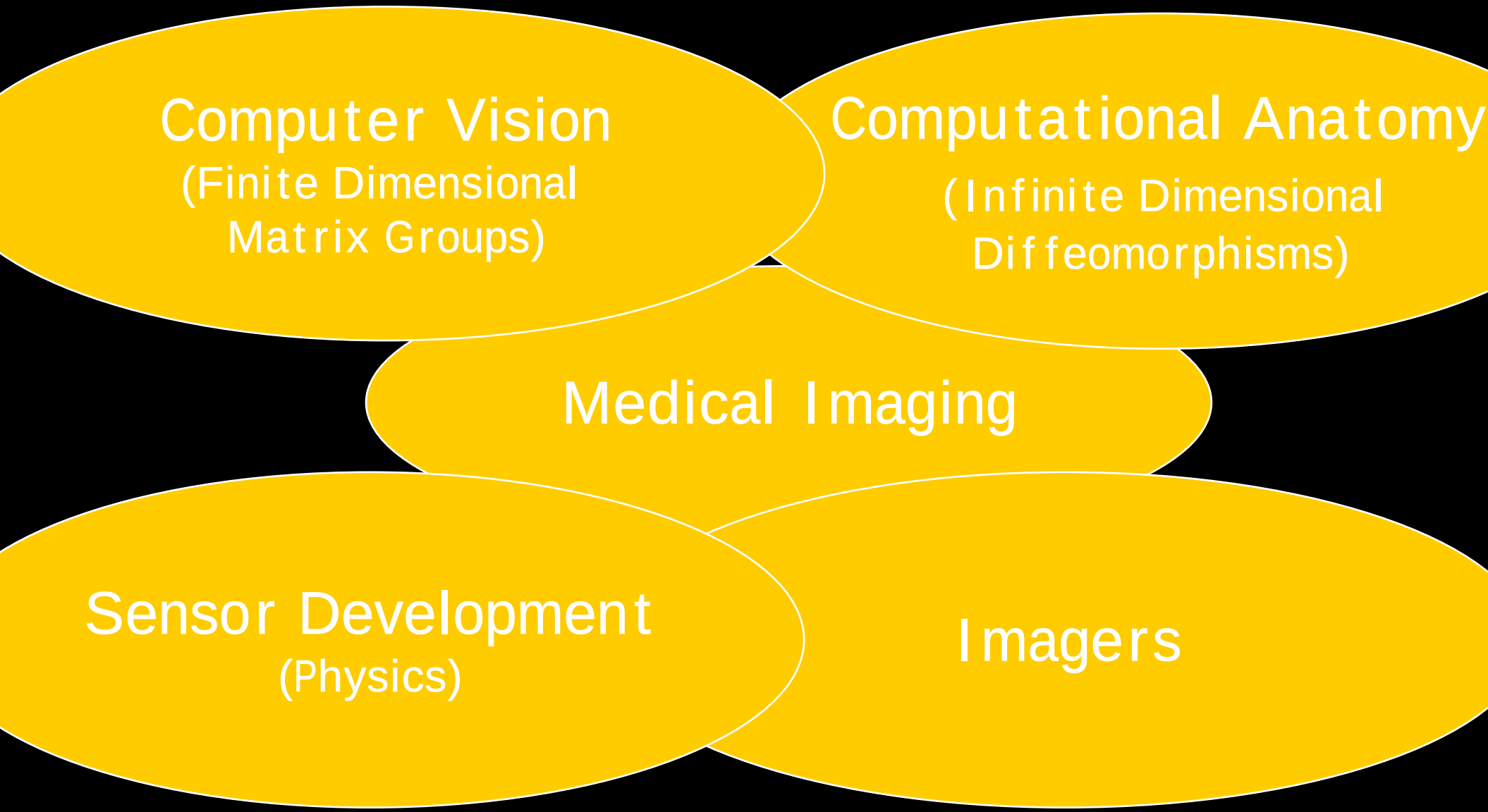
BIRN Enabled Computational Anatomy

Michael I. Miller
& Carey Priebe

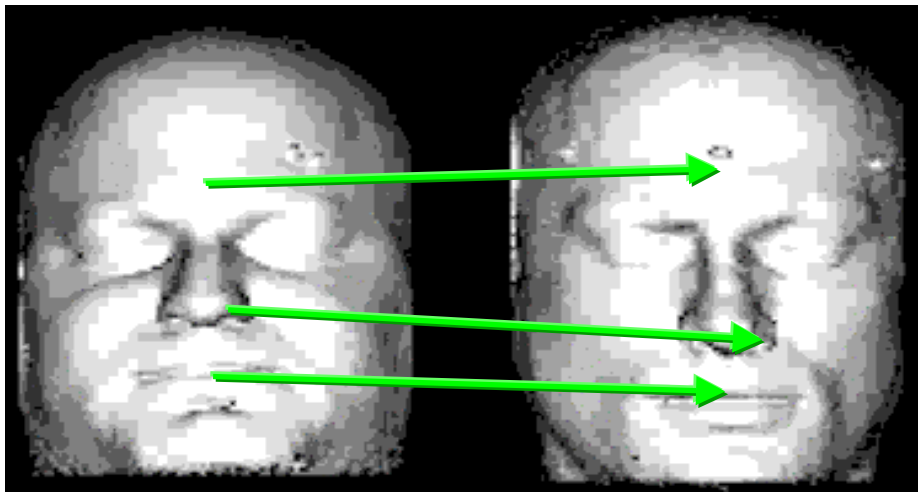
The Rosen Lecture, BIRN Florida 2005

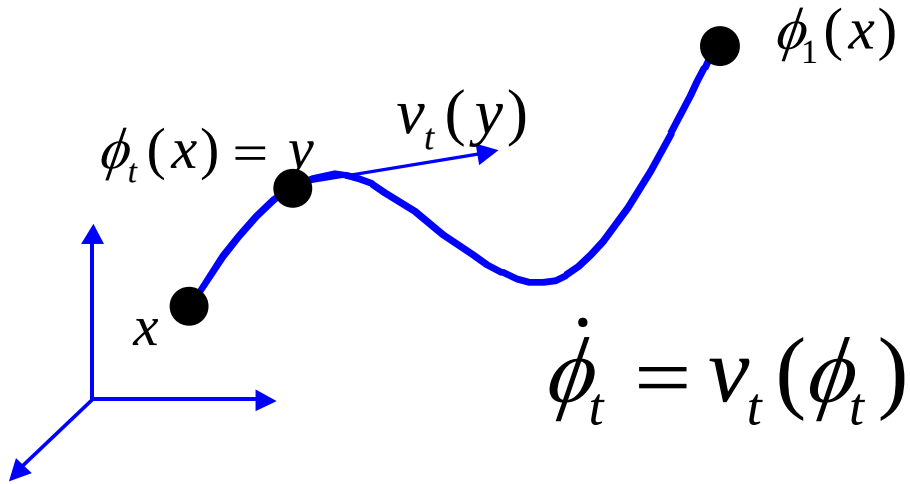

Computer Vision
(Finite Dimensional
Matrix Groups)
Computational Anatomy
(Infinite Dimensional
Diffeomorphisms)
Medical Imaging
Sensor Development
(Physics)
Imagers

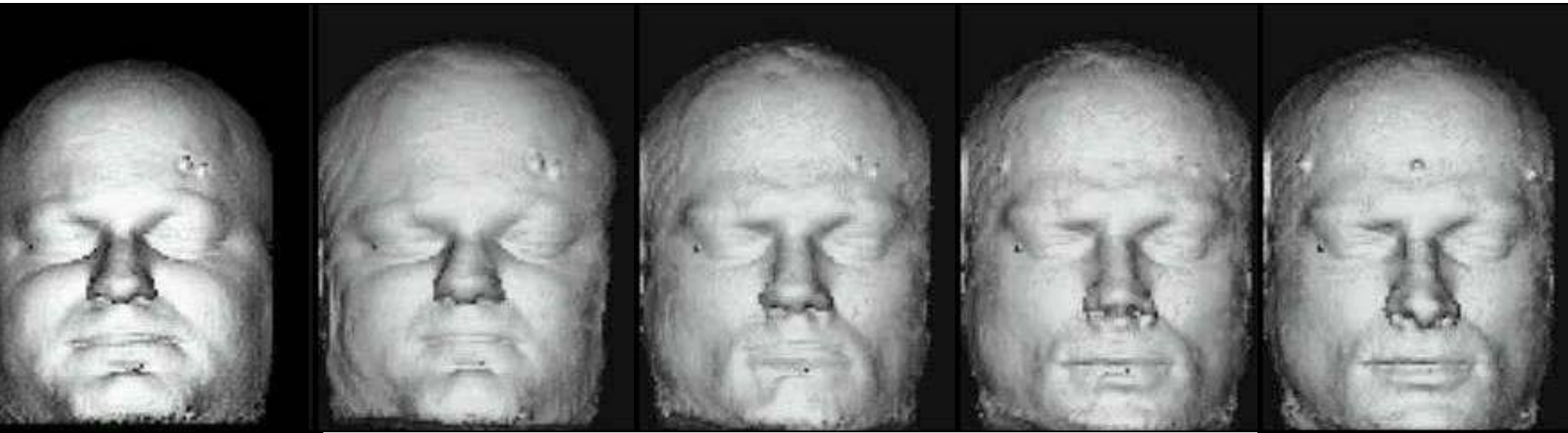
"In a very large part of morphology, our essential task lies in the comparison of related forms rather in the precise definition of each; …. This process of comparison, of recognizing in one form a definite permutation or deformation of another, … is the Method of Coordinates,on which is based the Theory of Transformations".

D'Arcy Thompson, On Growth and Form, 1917.

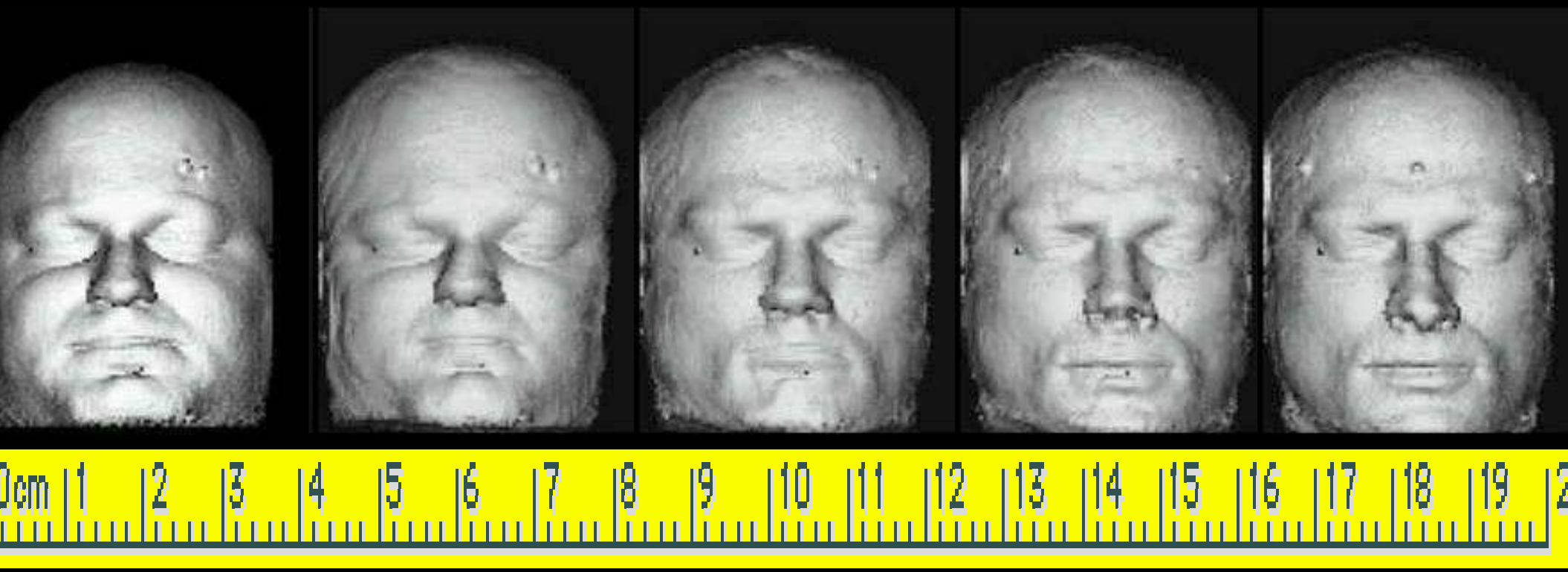
Anatomies are generated via flows of transformations (large deformation diffeomorphisms).





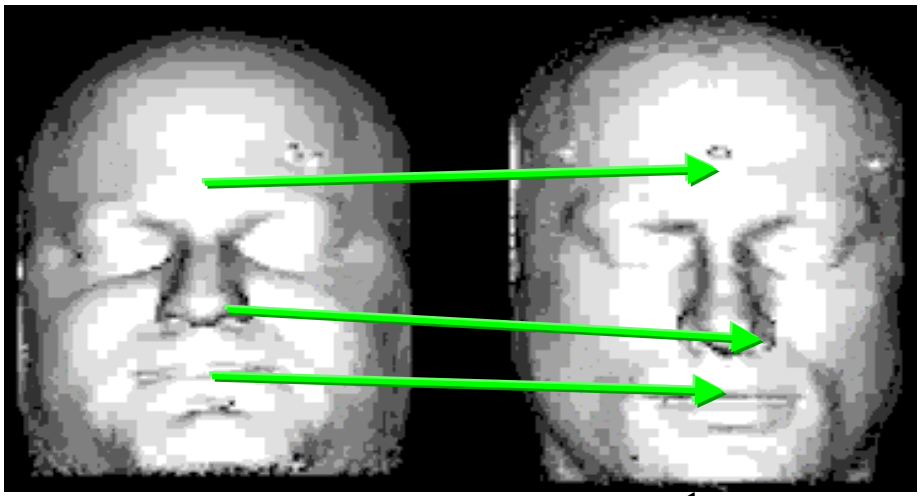


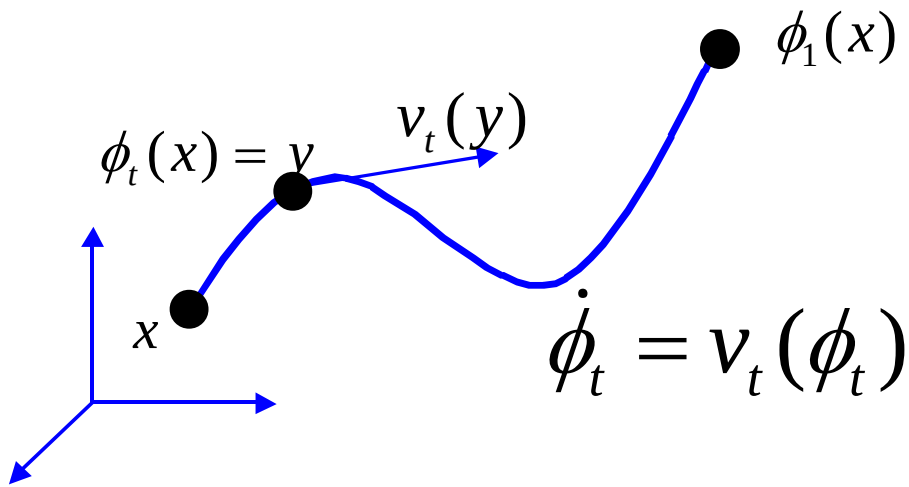
We make the anatomies into a metric space
(a Riemannian manifold like the sphere).



Metric distance is the length of
the shortest flow connecting the anatomies.

Metric is shortest length flow connecting





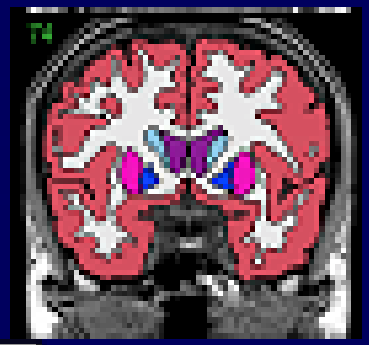
$$\rho(I_0, I_1) = inf_{\phi:\dot{\phi}=v(\phi)} \int_0^1 \| v_t \|_L \, dt$$

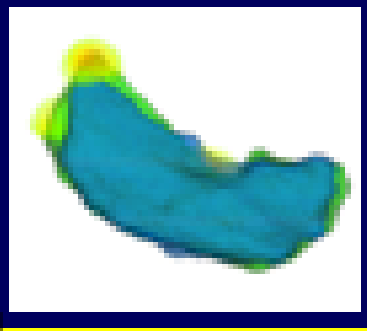
subject to

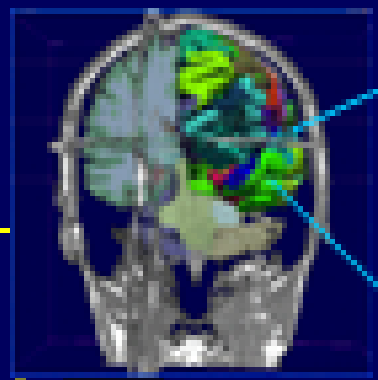
$$I_0 \circ \phi_1 = I_1$$

So LDDMM is the computational code for generating the shortest length flow.

Faisal Beg
Beg,Miller,Trouve Younes IJCV, 2005







3 MGH Segmentation

4 CIS-KKI LD-DMMVShape Analysis of Segmented Structures

5 BWH Visualization

UCSD Supercomputing

1 Data Donor Sites

De-identification And upload

2

SRB

Goal: comparison and quantification of structures' shape and volumetric differences across patient populations

Hippocampi

Jorge
001452043065

Randy
001446632245

Steve
001488460524

BIRN DAT Study
Buckner (WU), Fischl (MGH)

45-subject BIRN data set with 3 classes

- 21 control subjects
- 18 Alzheimer subjects
- 6 semantic dementia subjects

Total of 45 x 45 LDDMMs required

- 45x45 matrices (*i*,*j*)-th entry represents the LDDMM from the *i*-th subject to the *j*-th subject for the left hippocampus

Jorge

Randy

Steve

BIRN Empowerment: N^2 Metric Distances

	Jorge	Randy	Steve
Jorge	**0.0**	**4.9605169**	**7.5920452**
Randy	**4.3606305**	**0.0**	**6.8429535**
Steve	**7.1523336**	**6.758076**	**0.0**

The SASHA Project:
Data Mining of Federated National Database for Clustering and Disease Detection in Senile Dementia

Carey E. Priebe
Youngser Park

Center for Imaging Science
JHU

Feb. 14, 2005