

BIRN Enabled Computational Anatomy

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& Carey Priebe**



The Rosen Lecture, BIRN Florida 2005

Computer Vision
(Finite Dimensional
Matrix Groups)

Computational Anatomy
(Infinite Dimensional
Diffeomorphisms)

Medical Imaging

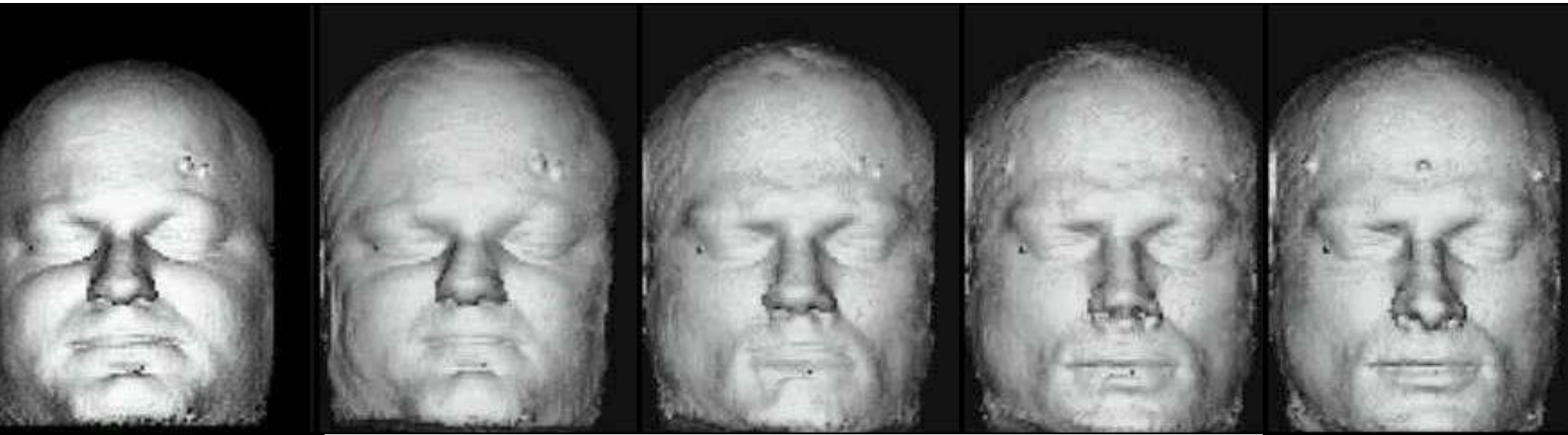
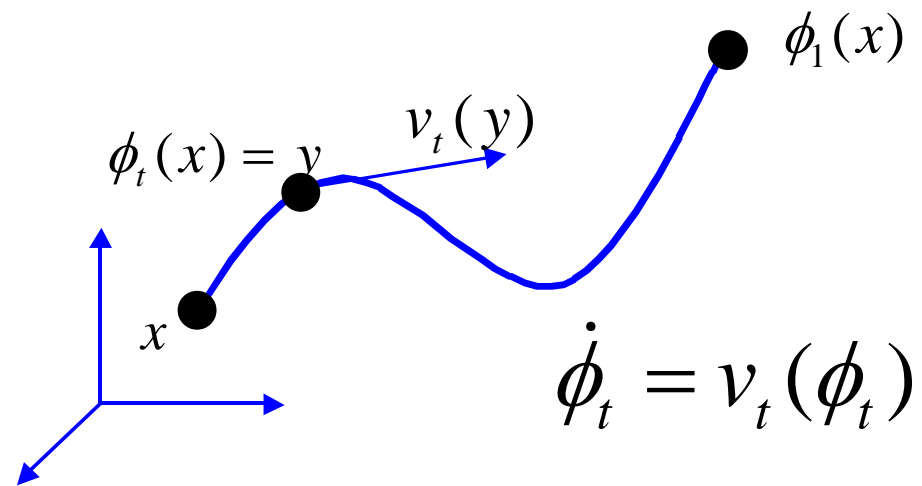
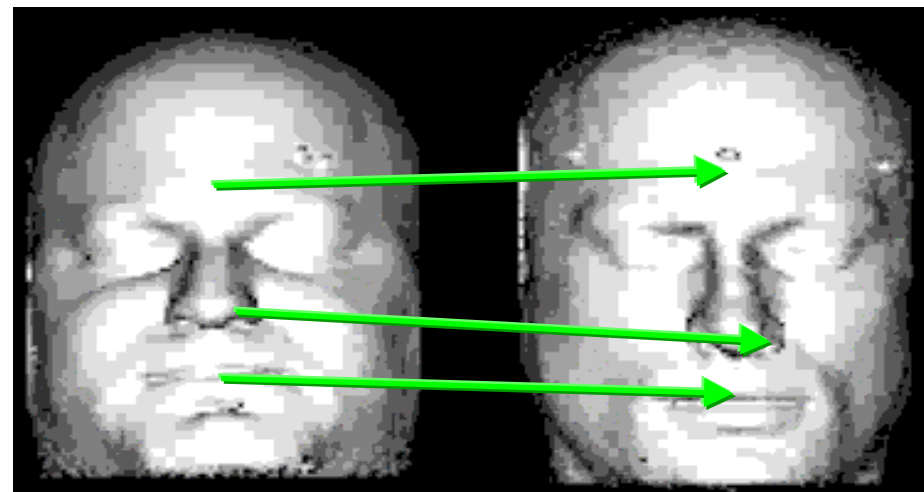
Sensor Development
(Physics)

Imagers

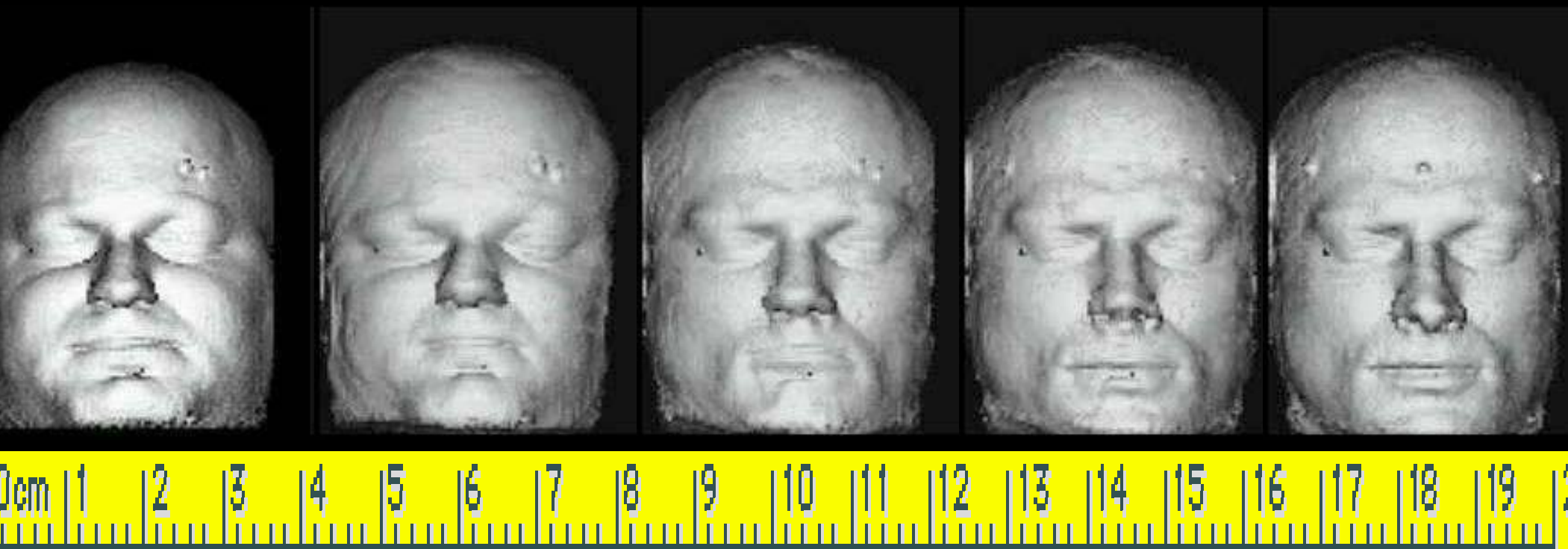
"In a very large part of morphology, our essential task lies in the comparison of related forms rather in the precise definition of each; ... This process of comparison, of recognizing in one form a definite permutation or deformation of another, ... is the Method of Coordinates, on which is based the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

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

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

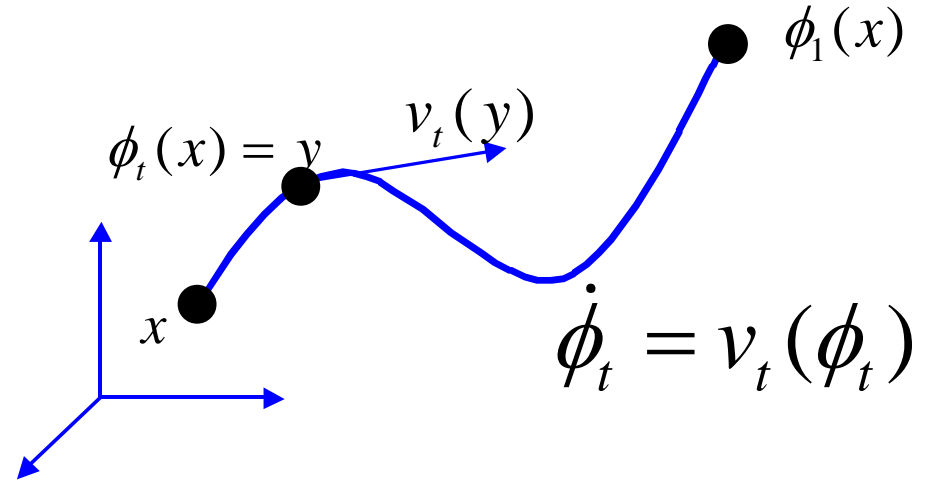
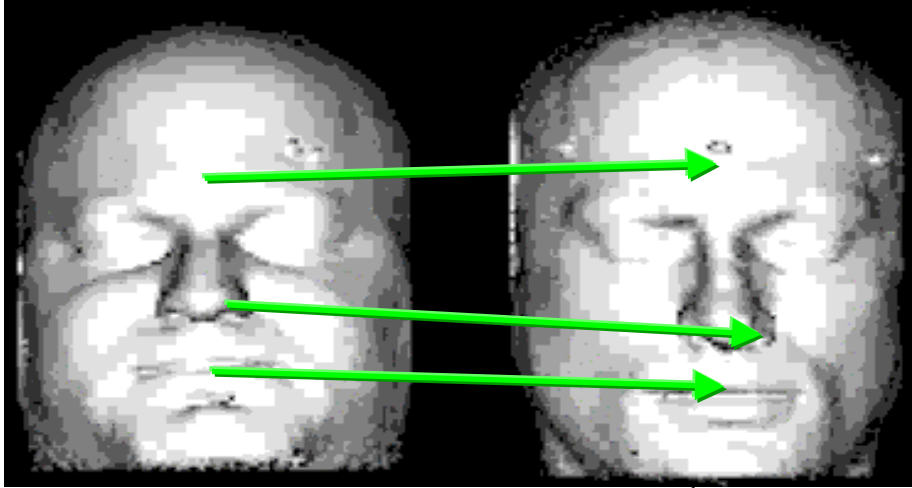


**We make the anatomies into a metric space
(a Riemannian manifold like the sphere).**



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

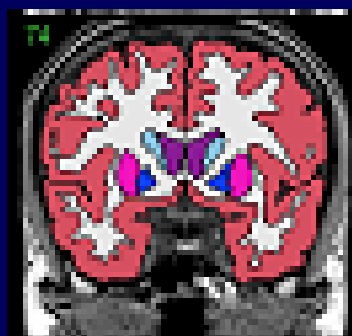
Metric is shortest length flow connecting



$$\rho(I_0, I_1) = \inf_{\phi: \dot{\phi} = v(\phi)} \int_0^1 \|v_t\|_L dt \quad \text{subject to} \quad I_0 \circ \phi_1 = I_1$$

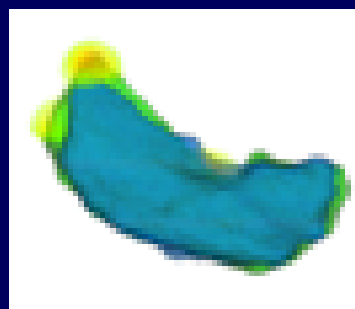
So LDDMM is the computational code for generating the shortest length flow.





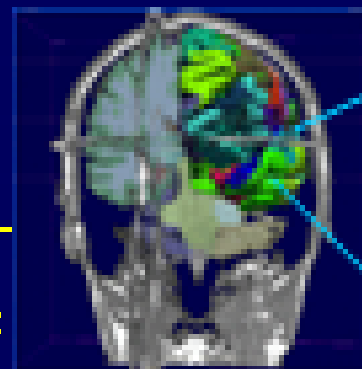
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MGH
Segmentation



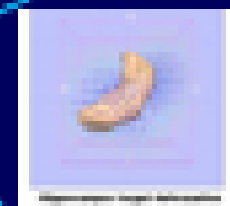
4

CIS-KKI
LD-DMM/Shape
Analysis
of Segmented Structures



5

BWH
Visualization



1

Data Donor
Sites

De-identification
And upload

2

SRB

Libero
Supercomputing

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**

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