

The ITKv4 registration framework

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October 5, 2015

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Brief image registration history

Image mapping and perception: 1877

Francis Galton: *Can we see criminality in the face?*



What about syphilis, mental illness?

Speaking of criminality...

Can we say anything about the U.S. Congress?



Naive

Affine

SyN

Maybe they should have used ANTs?

Image mapping & biology: 1917

D'Arcy Thompson: *Comparison of related forms*

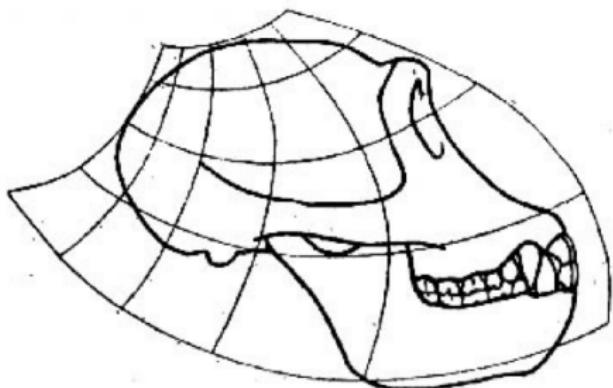


Fig. 550. Skull of chimpanzee.

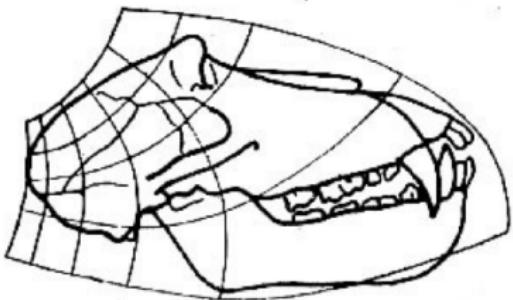
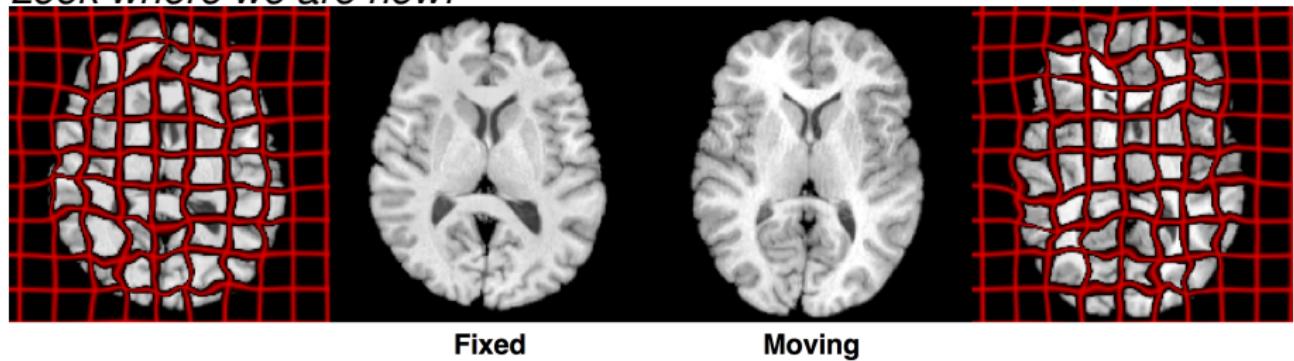


Fig. 551. Skull of baboon.

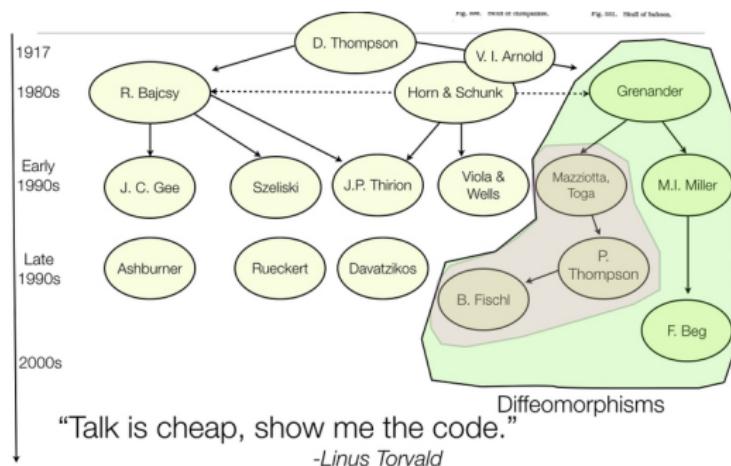
>

Image mapping & biology: current

Look where we are now!



Family tree



ITKv3 → ITKv4

Extensions of ITKv3

- Elastix
- Diffeomorphic Demons
- BrainsFit
- Advanced Normalization Tools (ANTs)

Basic components

- Optimizers (v4)
- Metrics (v4)
- Transforms
- Image registration methods (v4)

Optimizers (v4) and scales estimators

- Scales estimator

Metrics (v4)

■ Intensity metrics

- mean squares
- mutual information (Mattes and joint histogram)
- neighborhood cross-correlation
- demons
- global correlation

■ Point-set metrics

- iterative closest point
- point-set expectation
- Jensen-Havrda-Charvat-Tsallis

■ Multi-metrics

Transforms

- Linear (translation, rigid, ...)
- B-spline
- Displacement field (Gaussian, B-spline, SyN)
- Velocity field (exponential, time-varying)
- Composite

Image registration methods (v4)

- → Input:
 - Fixed image and initial fixed transform
 - Moving image and initial moving transform
 - metric(s)
- ← Output:
 - Optimized moving transform
- Special methods for SyN and velocity field transforms

Beyond original SyN

**frontiers in
NEUROINFORMATICS**

ORIGINAL RESEARCH ARTICLE

published: 28 April 2014

doi: 10.3389/fninf.2014.00044



The Insight ToolKit image registration framework

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**frontiers in
NEUROINFORMATICS**

METHODS ARTICLE

published: 23 December 2013

doi: 10.3389/fninf.2013.00039



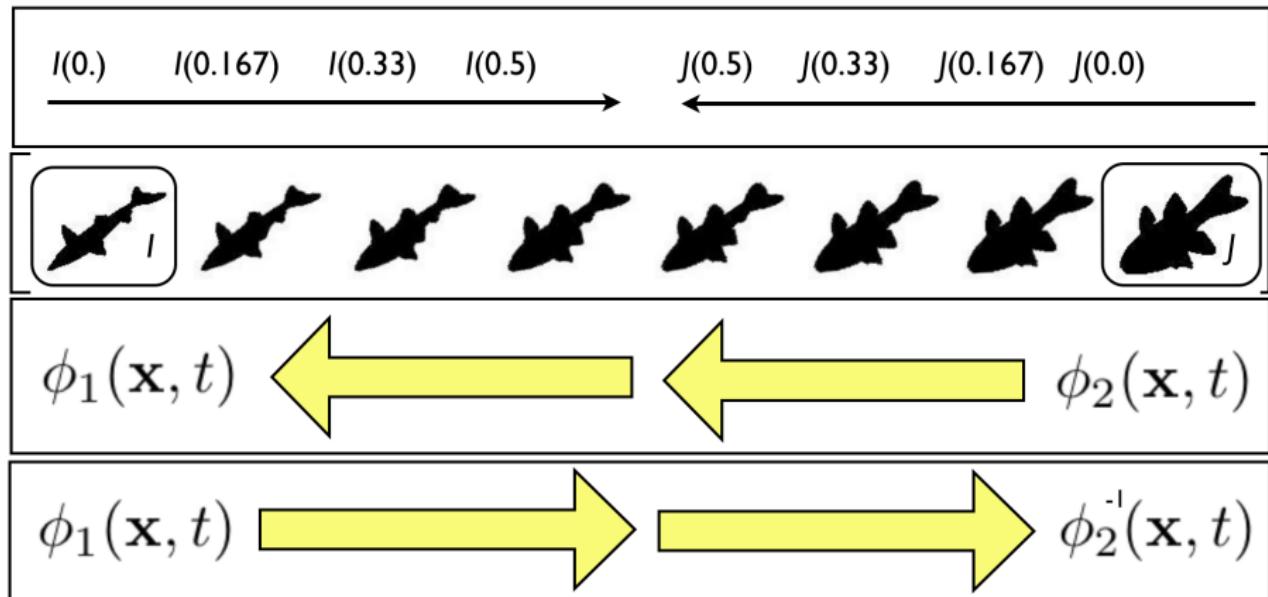
Explicit B-spline regularization in diffeomorphic image registration

Nicholas J. Tustison^{1*} and Brian B. Avants²

Brief ANTs introduction

Symmetric Normalization (SyN)

$$\int_{t=0}^{0.5} (\|\mathbf{v}_1(x, t)\|_L^2 + \|\mathbf{v}_2(x, t)\|_L^2) dt + \|I(\phi_1(x, 0.5)) - J_i(\phi_2(x, 0.5))\|^2$$



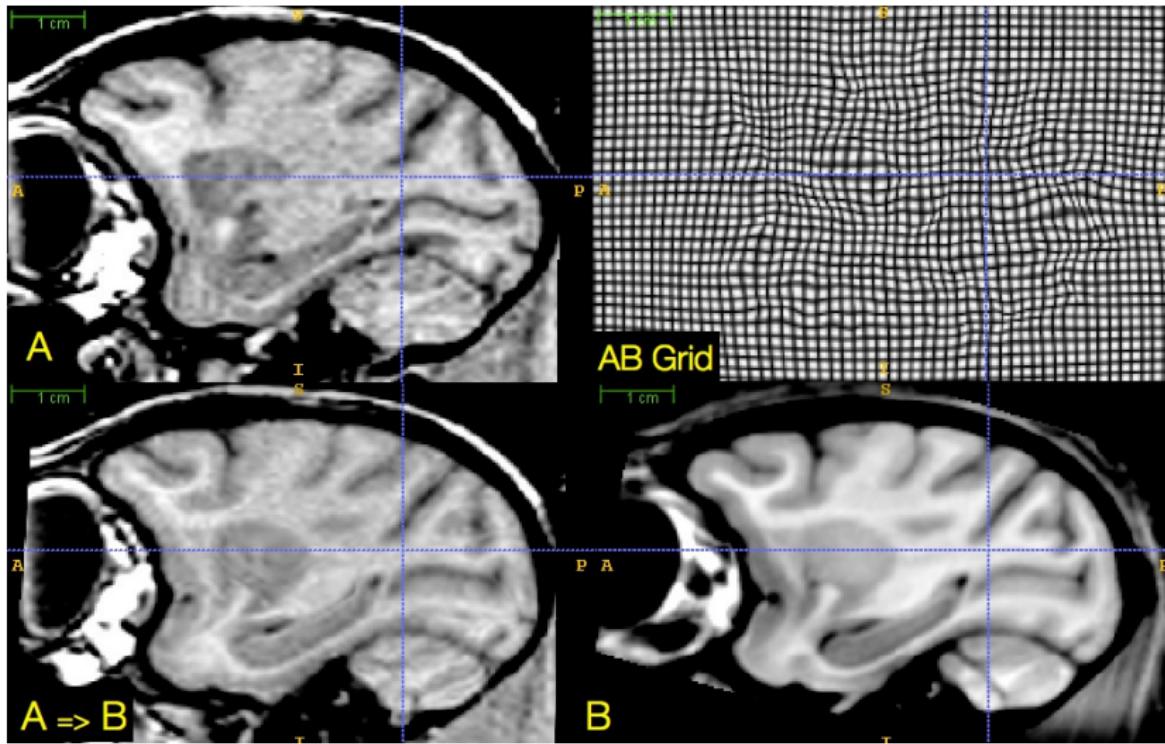
Notes: * Previously discussed Brian's work * The variant most widely used →

Diffeomorphisms: Occam's razor modeling



differentiable map with differentiable inverse

Diffeomorphisms: fine-grained and flexible maps



antsRegistration

```
$ antsRegistration --help
```

COMMAND:

antsRegistration

This program is a user-level registration application. It consists of a transform; an image metric; and iterative smoothing sigmas for each level. Note that dimensionality output, convergence, shrink-factors and smoothing-sigma are mandatory.

OPTIONS:

--version

Get Version Information.

-d, --dimensionality 2/3

Easy-to-use scripts

- antsRegistrationSyN.sh
- antsRegistrationSyNQuick.sh

```
$ antsRegistrationSyN.sh -d 3 \
    -f fixed.nii.gz \
    -m moving.nii.gz \
    -o output
```