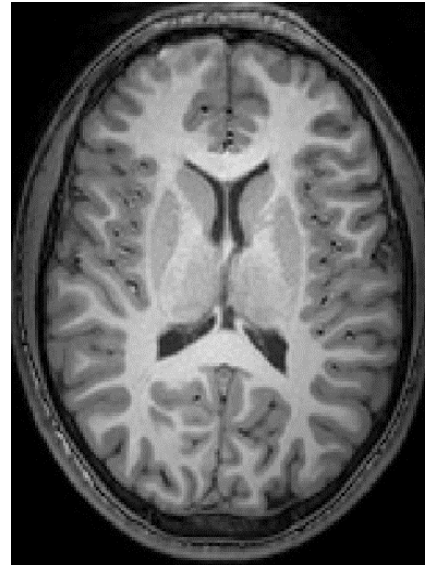
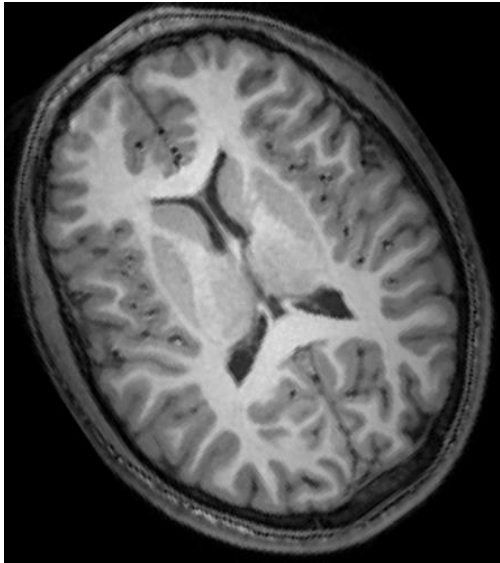
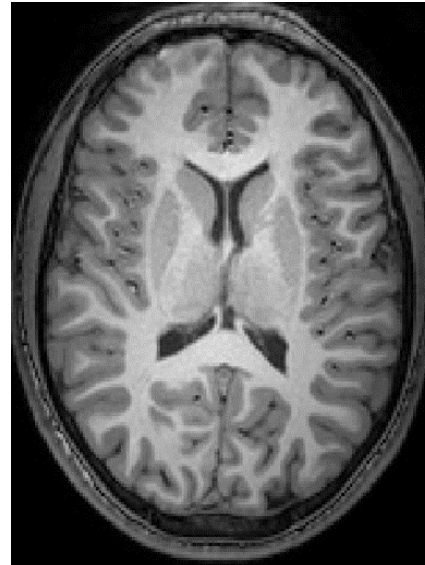
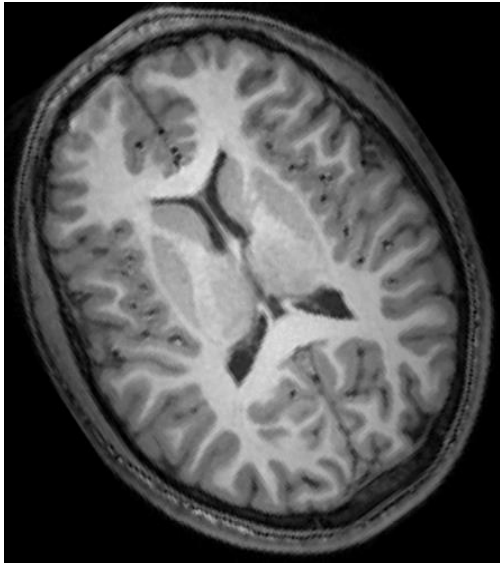


Image Registration



Feature based Registration



Rotation Matrix between 2 Vectors

Rotation Matrix between 2 Vectors

$$u = [x, y, z]^T, u' = [x', y', z']^T$$

$$\begin{bmatrix} x' \\ y' \\ z' \end{bmatrix} = R_v(\theta) \begin{bmatrix} x \\ y \\ z \end{bmatrix}$$

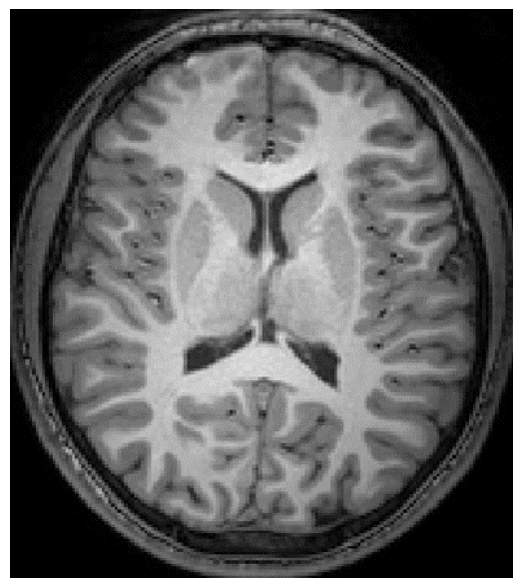
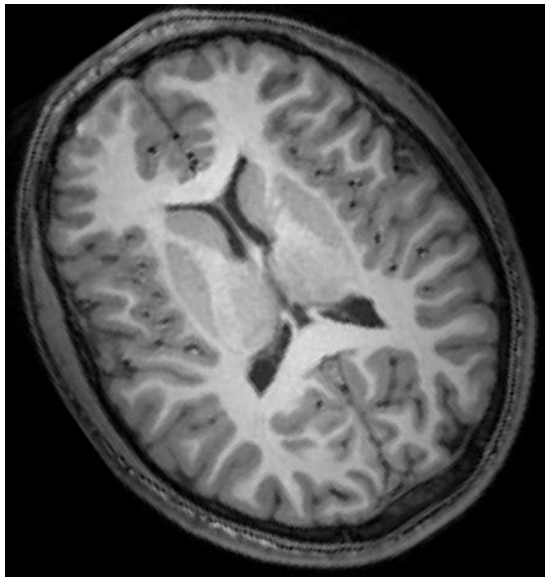
$$\cos \theta = \frac{u \cdot u'}{\|u\| \|u'\|} = \frac{xx' + yy' + zz'}{\sqrt{x^2 + y^2 + z^2} \sqrt{x'^2 + y'^2 + z'^2}}$$

$$\sin \theta = \sqrt{1 - \cos^2 \theta}$$

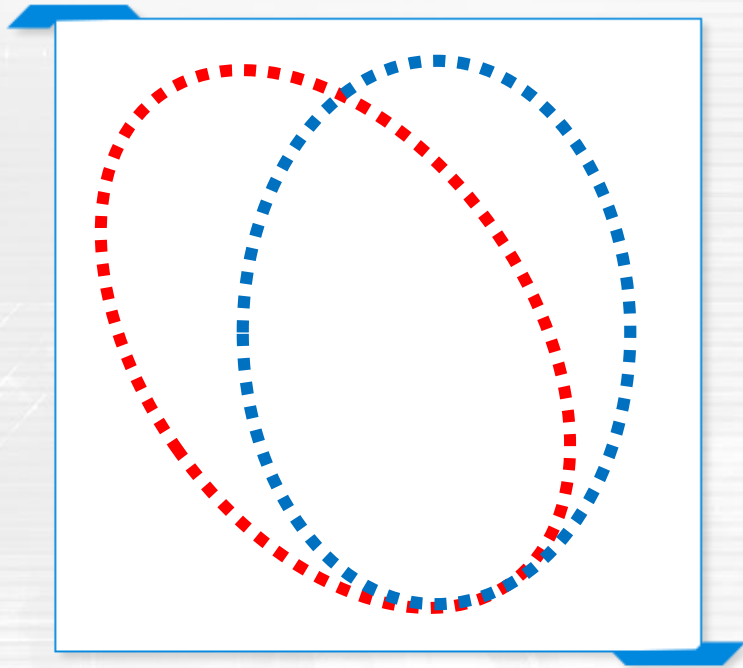
$$v = \frac{1}{\|u \times u'\|} u \times u'$$

$$\begin{bmatrix} ll(1 - \cos \theta) + \cos \theta & ml(1 - \cos \theta) - n \sin \theta & nl(1 - \cos \theta) + m \sin \theta \\ lm(1 - \cos \theta) + n \sin \theta & mm(1 - \cos \theta) + \cos \theta & nm(1 - \cos \theta) - l \sin \theta \\ ln(1 - \cos \theta) - m \sin \theta & mn(1 - \cos \theta) + l \sin \theta & nn(1 - \cos \theta) + \cos \theta \end{bmatrix}$$

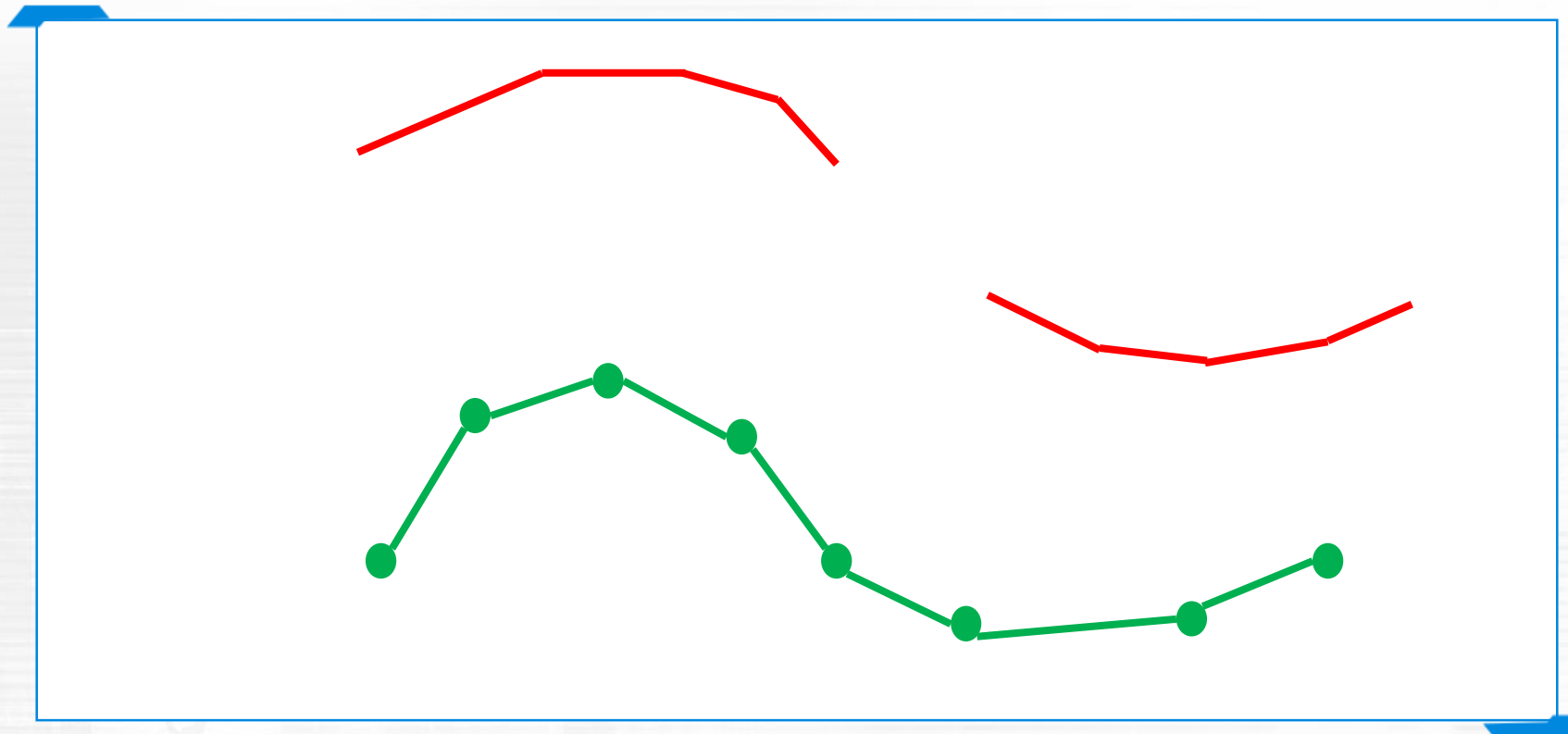
Iterative Closest Point



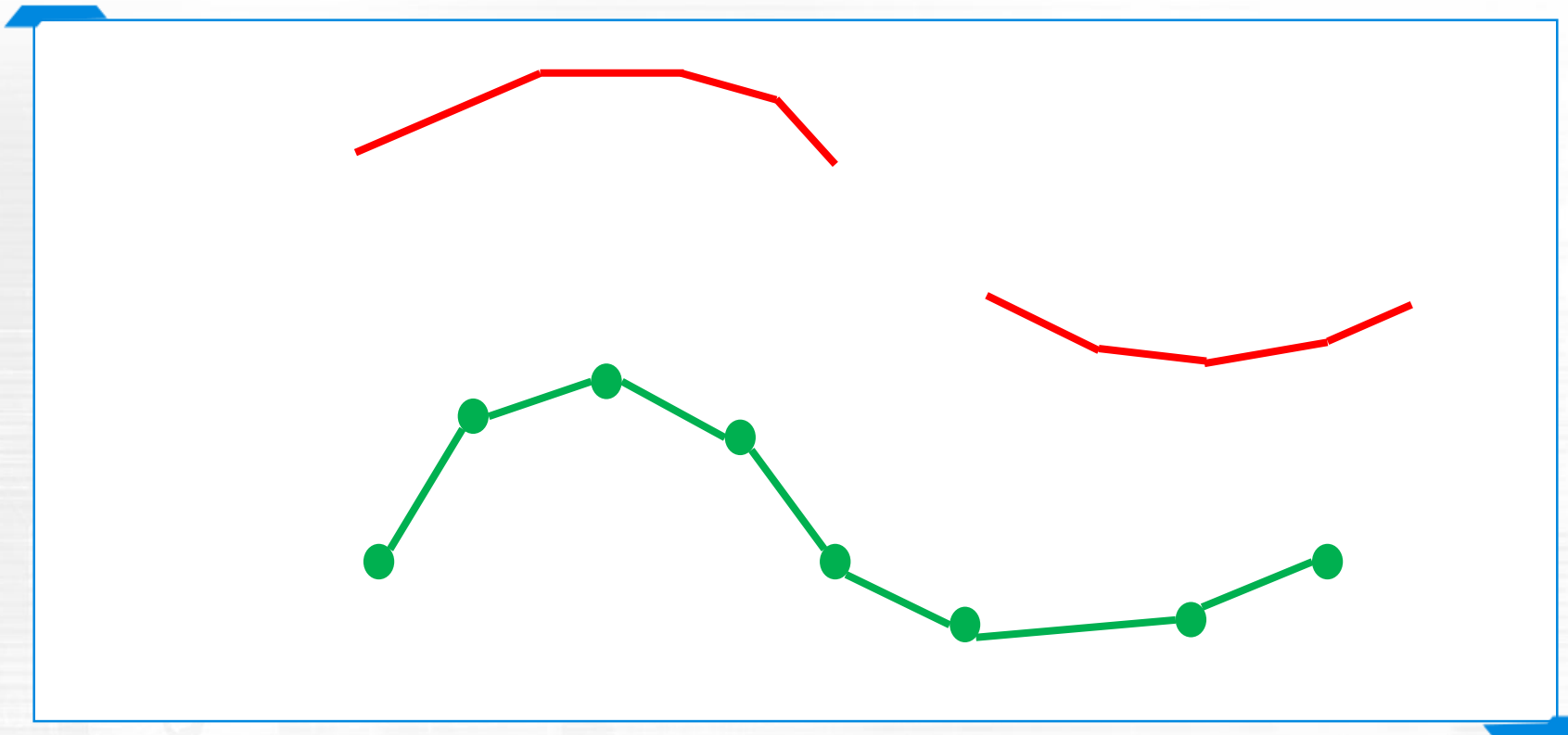
Iterative Closest Point



Non-rigid Registration



Non-rigid ICP Registration



Non-rigid ICP Registration

$$X := [X_1 \cdots X_n]^T$$

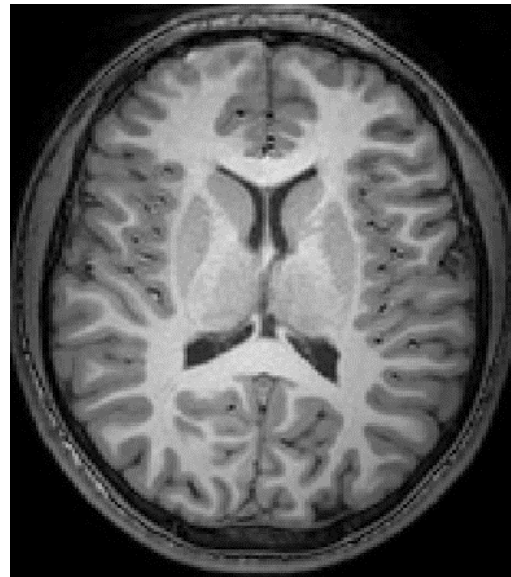
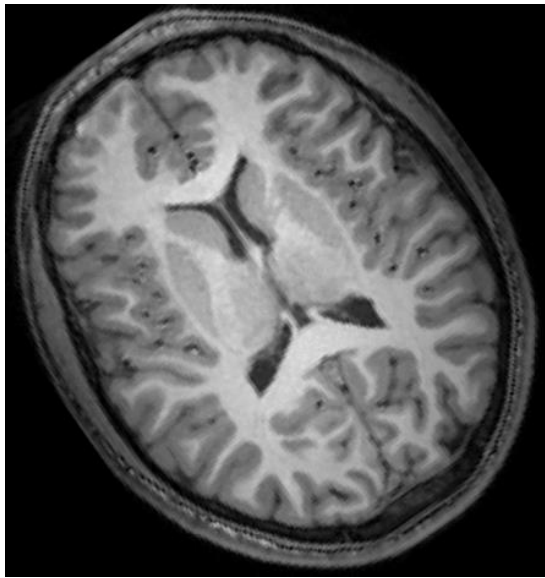
$$E_d(X) := \sum_{v_i \in V} w_i \text{dist}^2(T, X_i v_i)$$

$$E(X) := E_d(X) + \alpha E_s(X) + \beta E_l(X)$$

$$E_s(X) := \sum_{\{i,j\} \in \mathcal{E}} \| (X_i - X_j) G \|_F^2$$

$$E_l(X) := \sum_{(v_i, l) \in \mathcal{L}} \| X_i v_i - l \|^2$$

Spline based Registration

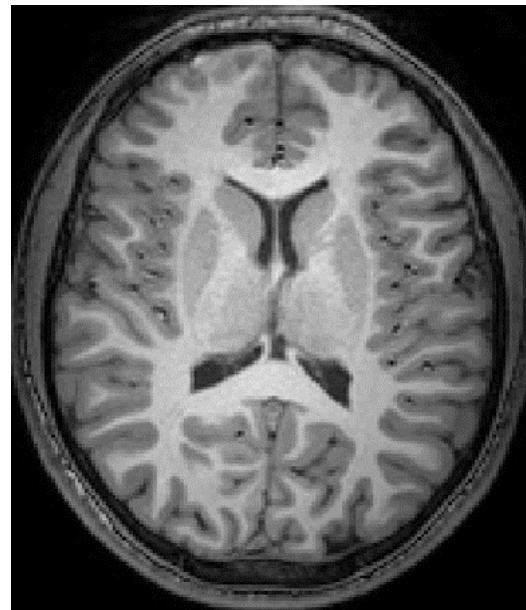
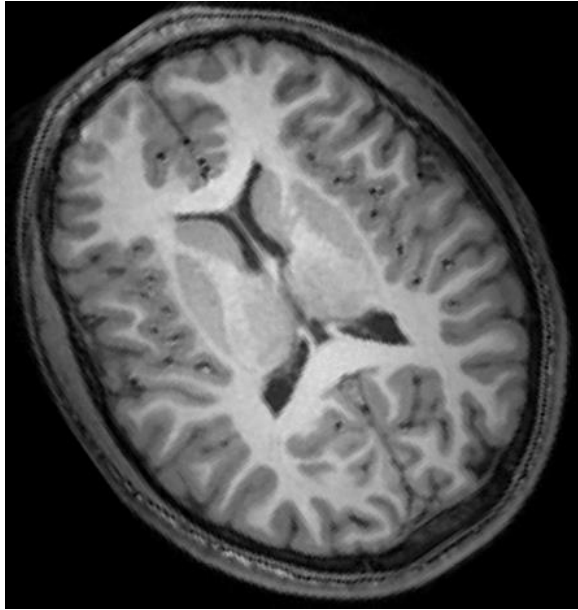


Spline based Registration

$$x' = \sum_i^I \sum_j^J a_{i,j} x^i y^j$$

$$y' = \sum_i^I \sum_j^J b_{i,j} x^i y^j$$

Non-rigid Registration



Multi-resolution

