Segmentation with Shape Priors

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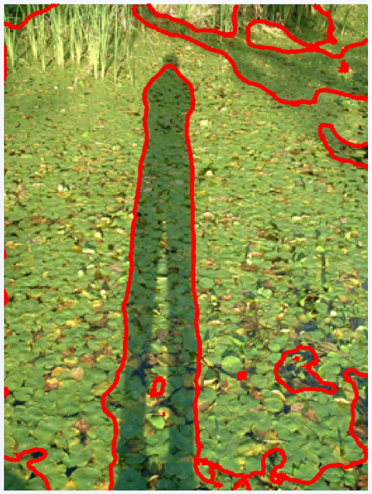
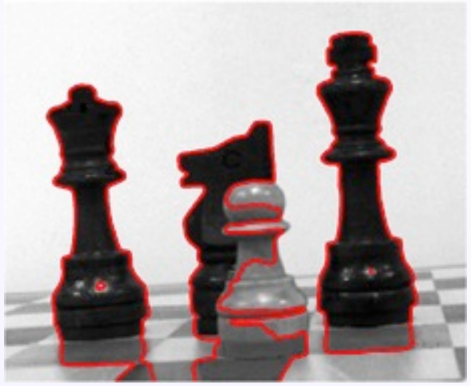
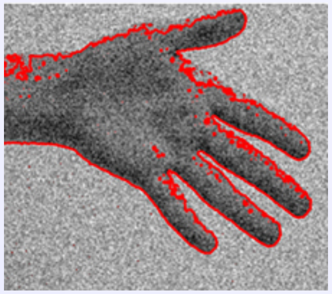
Bottom-up Segmentation



Clutter



Occlusion



Noise

Reflection

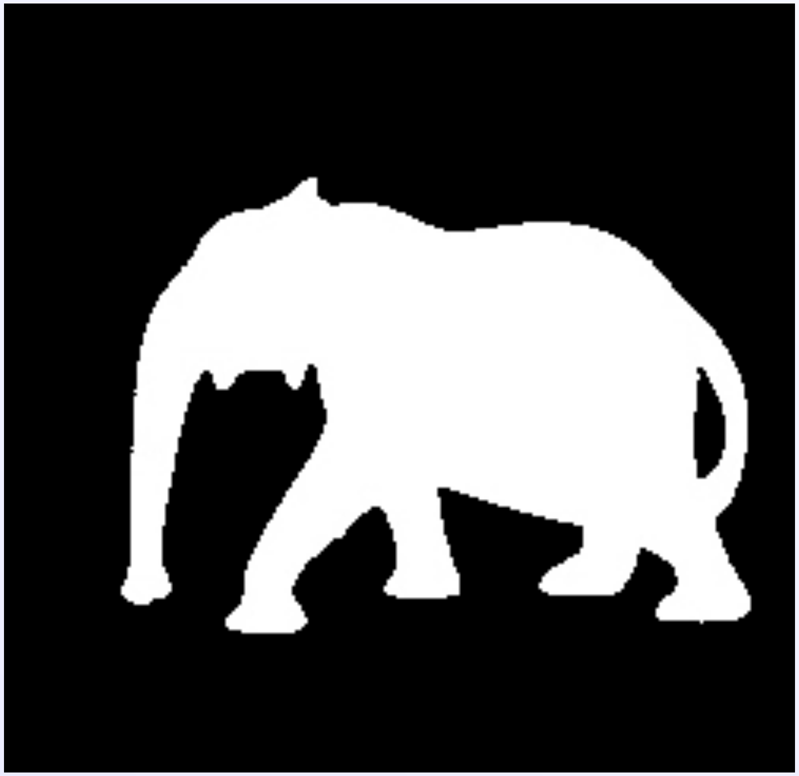
Prior based Segmentation

Prior image

To Segment

Riklin-Raviv, Kiryati, Sochen ECCV 04, ICCV 05, IJCV 06

Prior based Segmentation

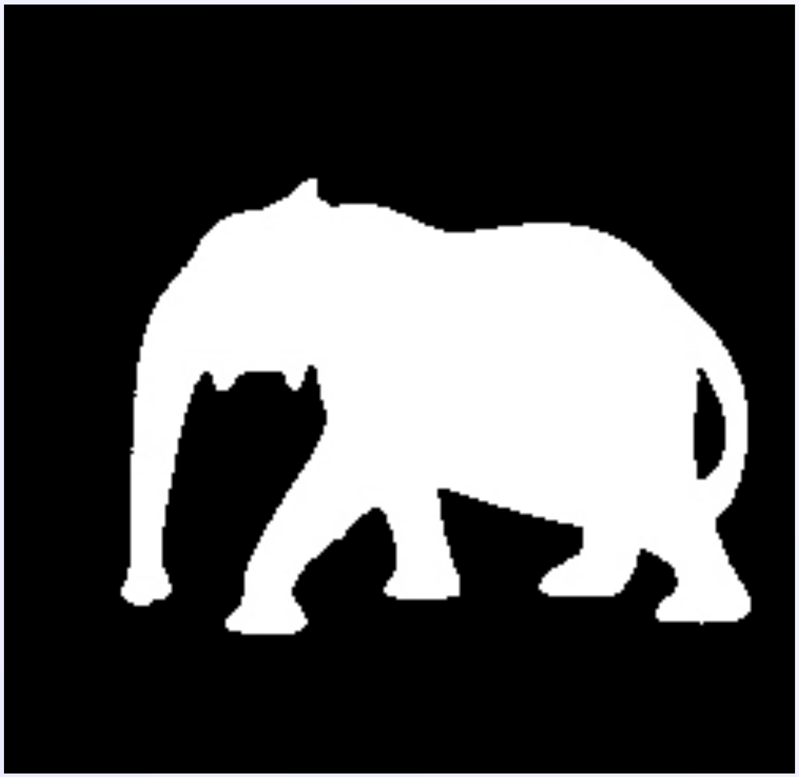


Prior shape

To Segment

Riklin-Raviv, Kiryati, Sochen ECCV 04, ICCV 05, IJCV 06

Prior based Segmentation



Prior shape

Segmentation

Riklin-Raviv, Kiryati, Sochen ECCV 04, ICCV 05, IJCV 06

Mutual Segmentation

Riklin-Raviv, Sochen , Kiryati POCV 06

Mutual Segmentation

Riklin-Raviv, Sochen , Kiryati POCV 06

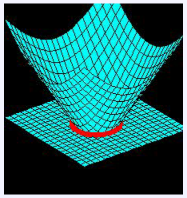
Symmetry-based Segmentation

Riklin-Raviv, Kiryati, Sochen CVPR 06

Symmetry-based Segmentation

Riklin-Raviv, Kiryati, Sochen CVPR 06

Talk Overview



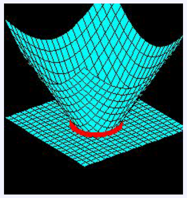
- Level-sets formulation
  - Shape representation
  - Segmentation

- Prior based segmentation

- Mutual segmentation

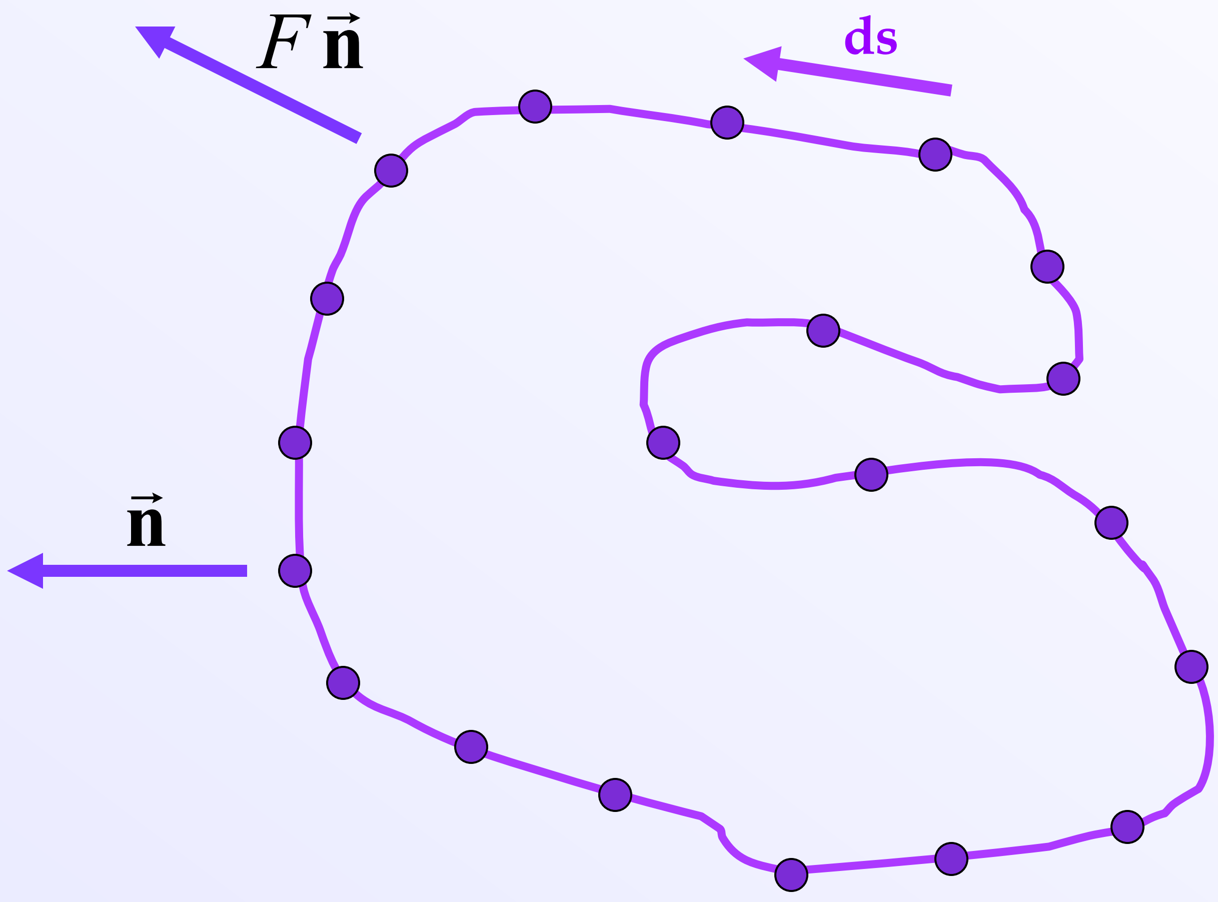
- Symmetry based segmentation

Talk Overview

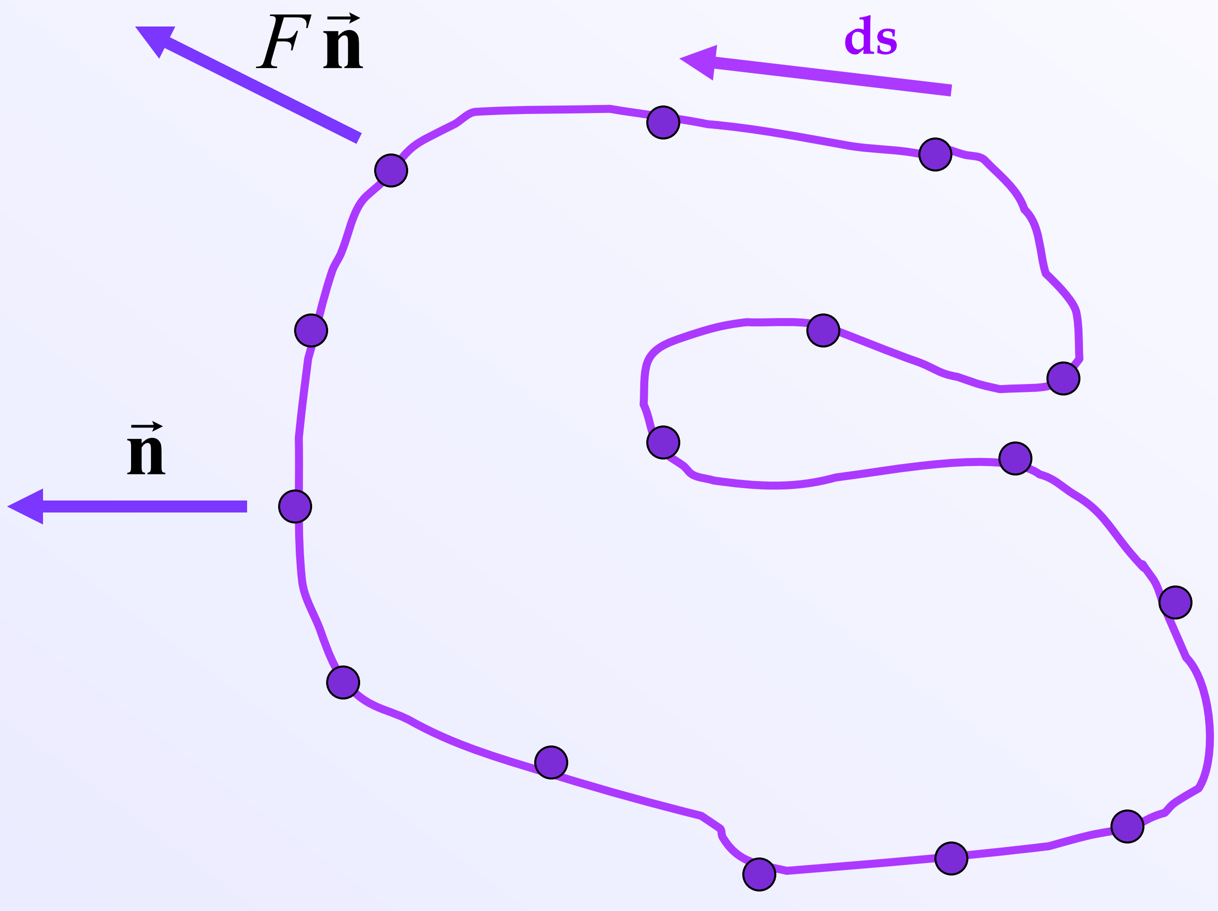


- Level-sets formulation
  - Shape representation
  - Segmentation
- Prior based segmentation
- Mutual segmentation
- Symmetry based segmentation

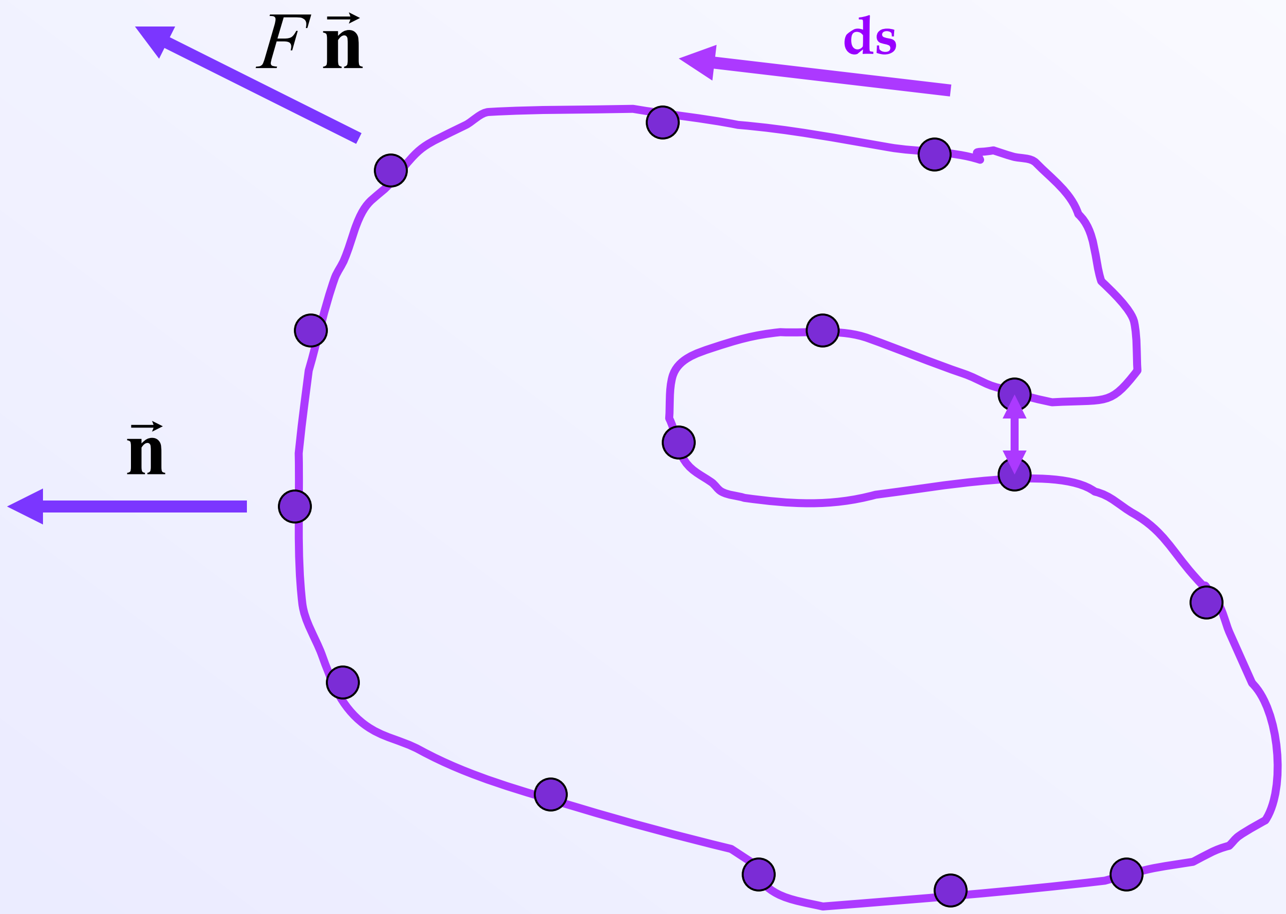
Parametric Representation



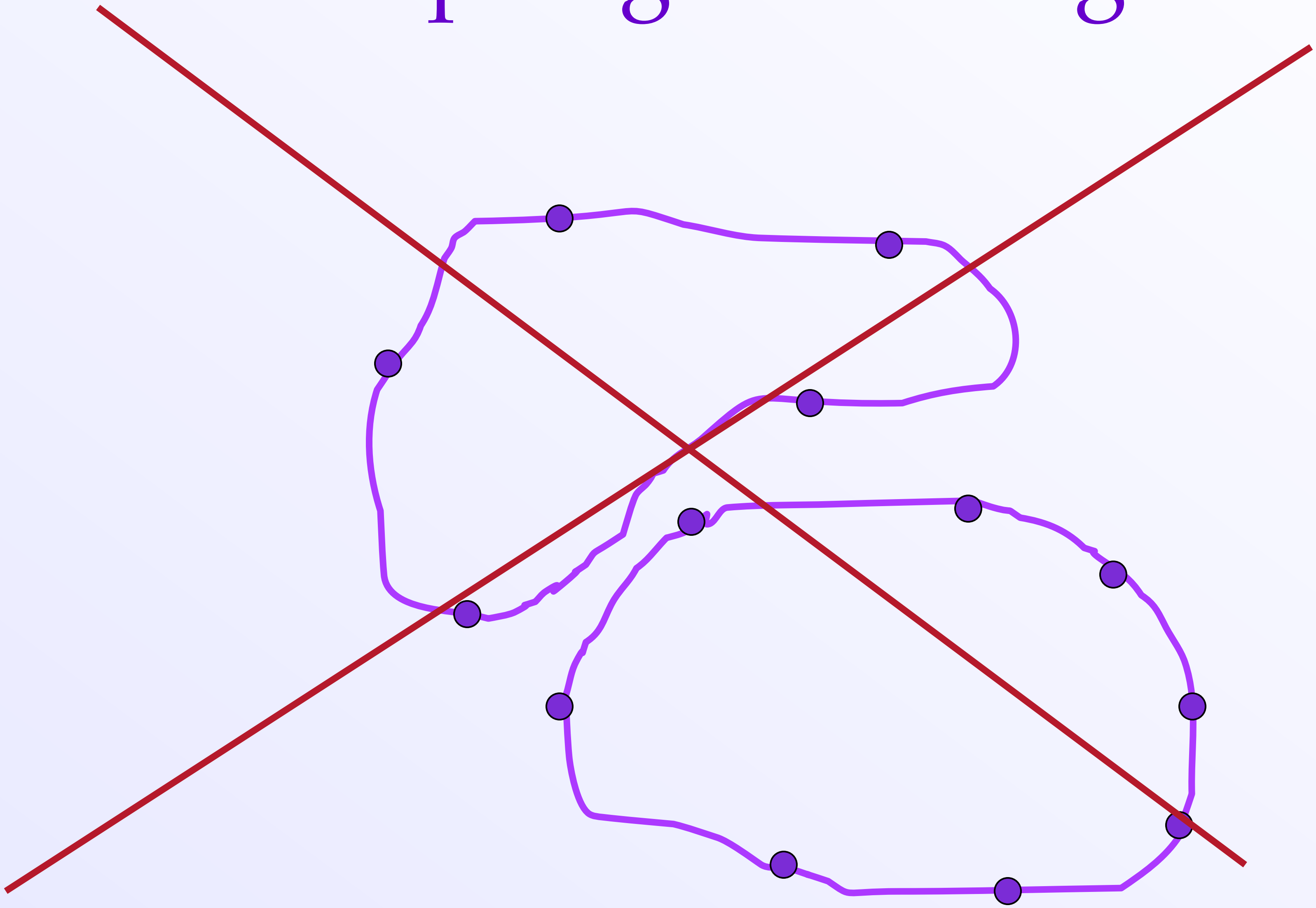
Parameterization - Dependency



Self Intersections



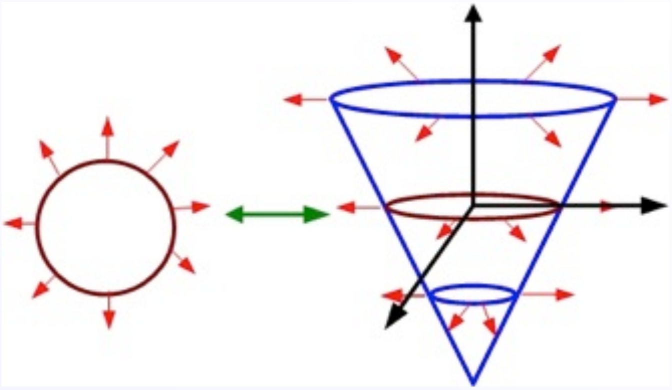
Cannot Handle Automatic Topological Changes

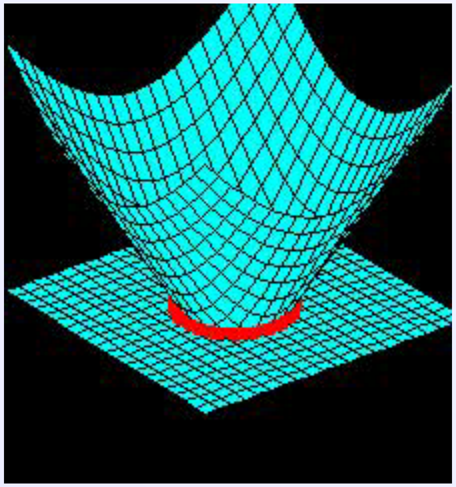


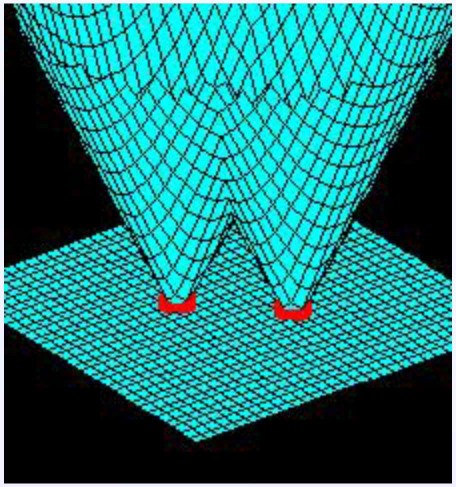
The Level-set Approach

Level-set function $\phi : \Omega \rightarrow \Re$

Embedded contour $C = \left\{ x \in \Omega \mid \phi(x) = 0 \right\}$



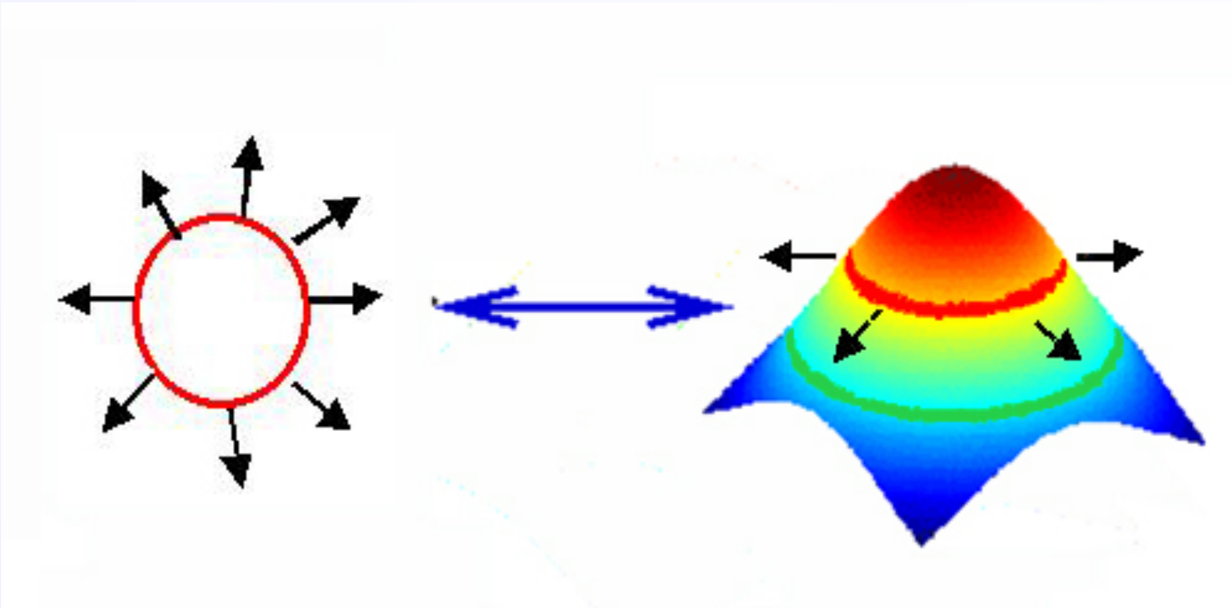




Osher & Sethian 1988

http://math.berkeley.edu/~sethian/level_set.html

The Level-set Approach

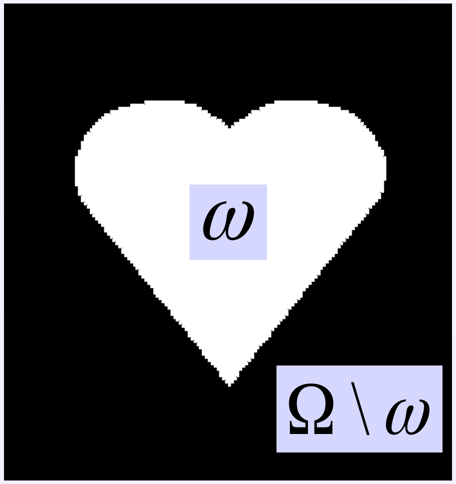


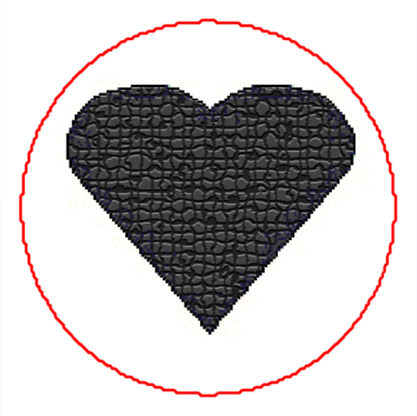
The original front.
Front lies in x-y plane

The level-set function.
Front is intersection of surface
and x-y plane

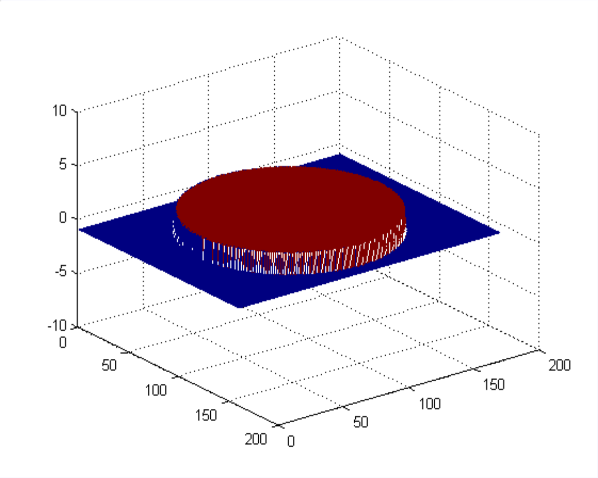
Osher-Sethian 1988

Dynamic Shape Representation





Active Contour



Evolving Level-Set Function

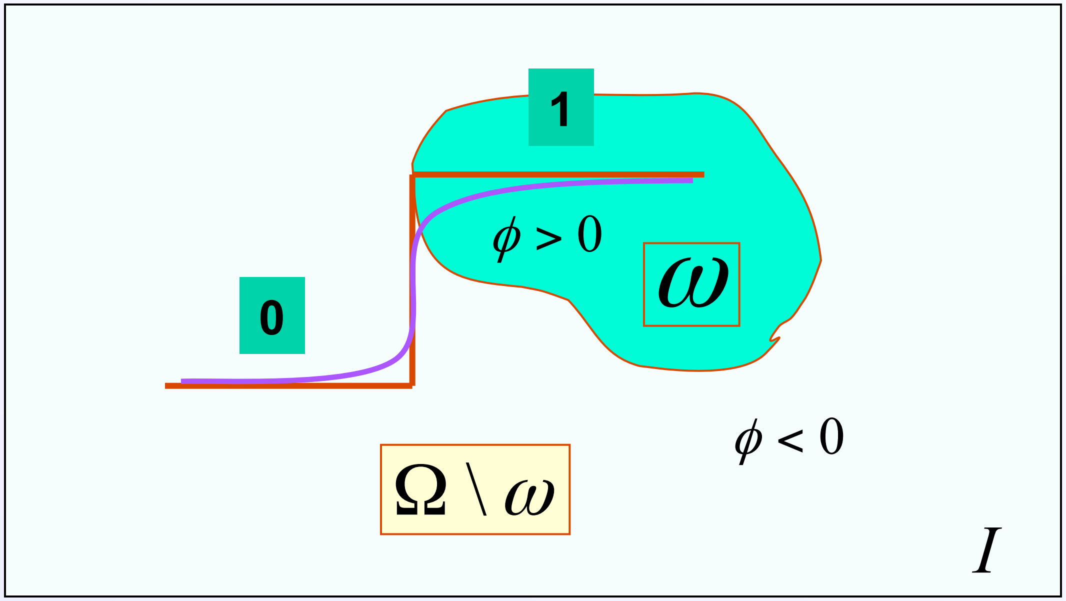
Image domain Ω

Object domain $\omega \in \Omega$

Level-set function $\phi : \Omega \rightarrow \Re$

Embedded contour $C = \left\{ \mathbf{x} \in \Omega \mid \phi(\mathbf{x}) = 0 \right\}$

Dynamic Shape Representation

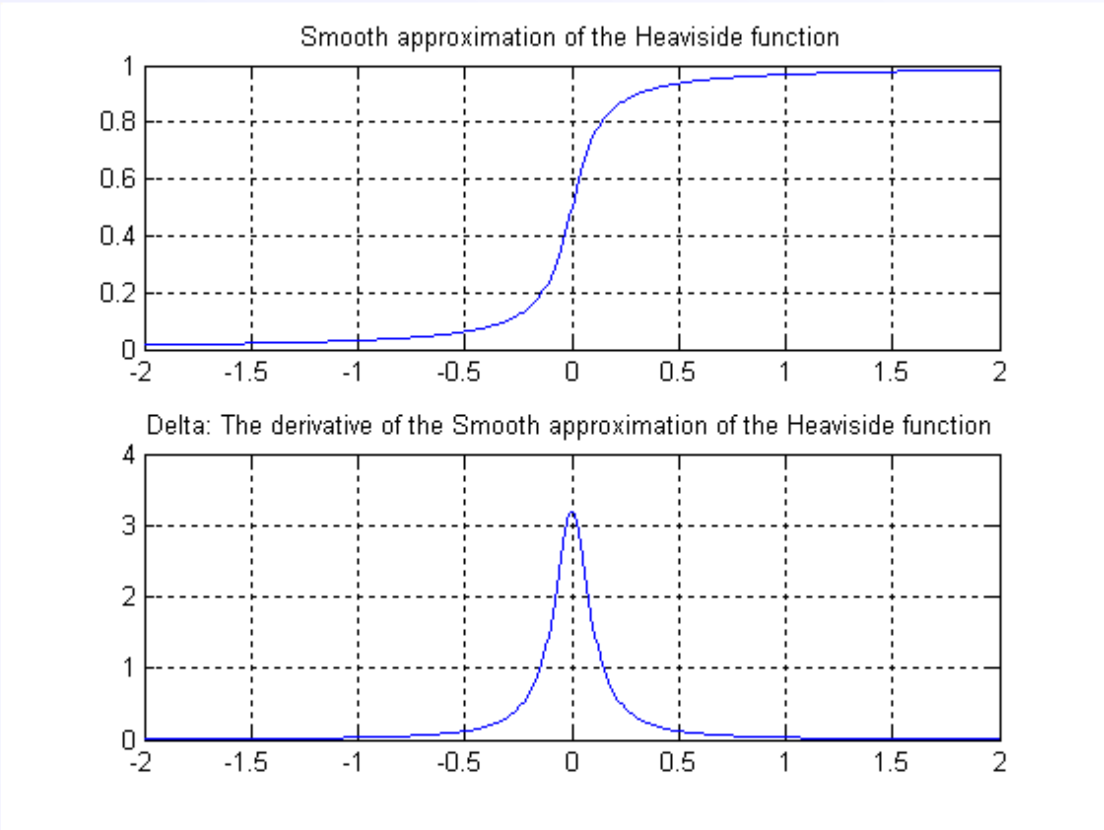


$$H_\varepsilon(\phi) = \begin{cases} 1 & \phi \geq 0 \\ 0 & \text{otherwise} \end{cases} \quad \Longrightarrow \quad \chi(\mathbf{x}) = \begin{cases} 1 & \mathbf{x} \in \omega \\ 0 & \mathbf{x} \in \Omega \setminus \omega \end{cases}$$

Heaviside function

Object indicator function

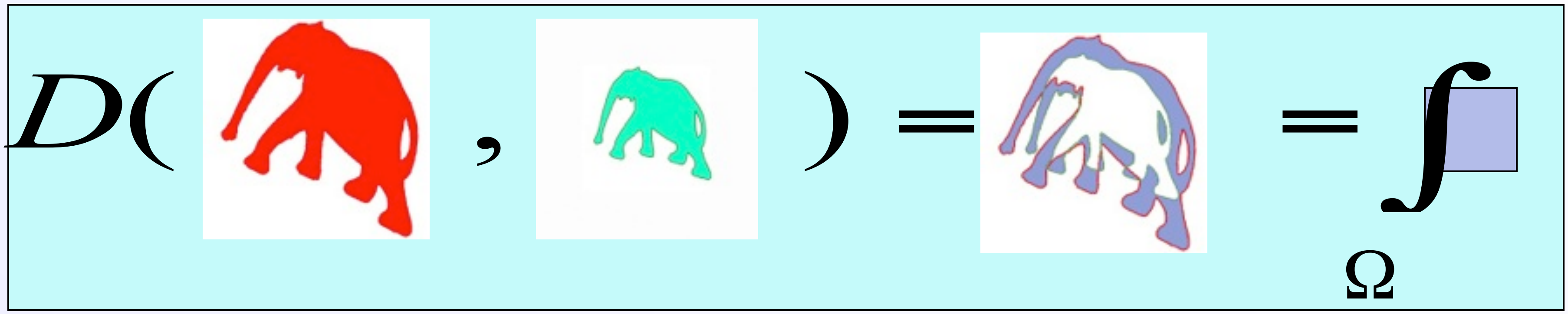
Reguralized Heaviside and Delta Functions



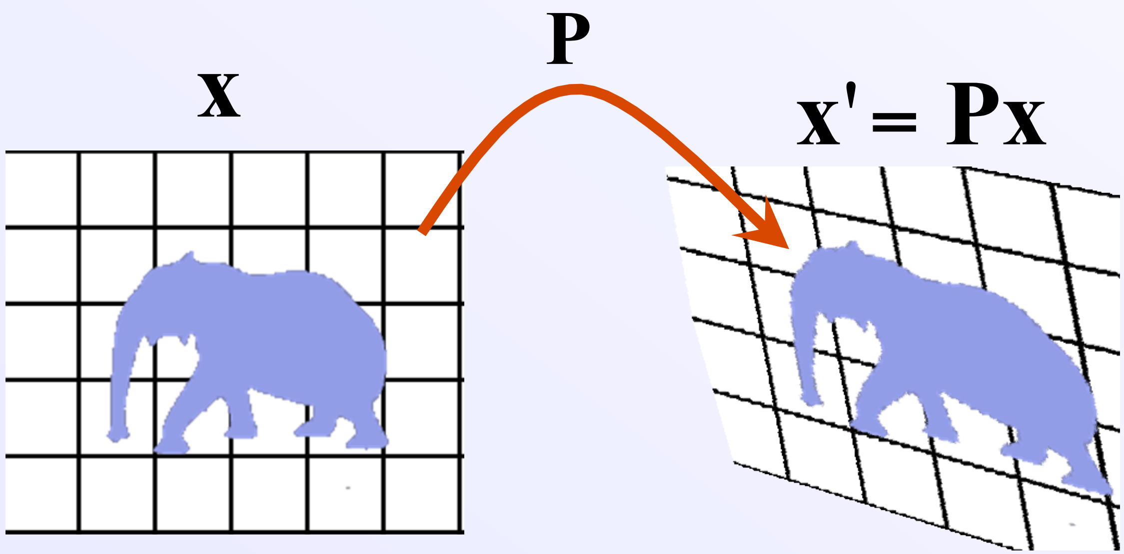
$$H_\varepsilon(\phi) = \frac{1}{2}\left(1 + \frac{2}{\pi}\arctan\left(\frac{\phi}{\varepsilon}\right)\right)$$

$$\delta_\varepsilon(\phi) = \frac{1}{\pi}\frac{\varepsilon}{\varepsilon^2 + \phi^2}$$

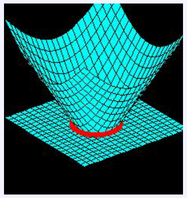
Dissimilarity Measure



Transformations



Talk Overview

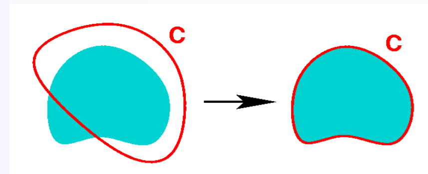


- Level-sets formulation
  - ➢ Shape representation
  - ➢ Segmentation
- Prior based segmentation
- Mutual segmentation
- Symmetry based segmentation

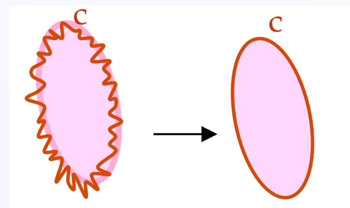
Cost Functional

$$E(\phi, \mathbf{P}) = \int_{\Omega}$$

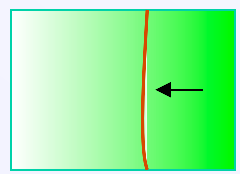
Region based



+ Smoothness



+ Edge based

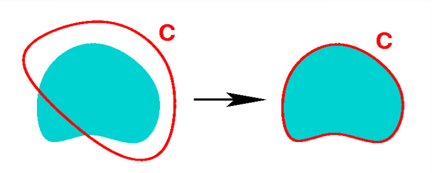


+ Shape

$d\mathbf{x}$

Region based Term

Piecewise constancy assumption



$$E_{RB}(u_{in}, u_{out}, C) = \int_{inside(C)} (I - u_{in})^2 \, d\mathbf{x} + \int_{outside(C)} (I - u_{out})^2 \, d\mathbf{x}$$

$$\int_{inside\,C} d\mathbf{x} \Rightarrow \int_{\Omega} H_{\varepsilon}(\phi) d\mathbf{x} \qquad \int_{outside\,C} d\mathbf{x} \Rightarrow \int_{\Omega} [1 - H_{\varepsilon}(\phi)] d\mathbf{x}$$

$$E_{RB}(u_{in}, u_{out}, \phi) = \int_{\Omega} [(I - u_{in})^2 H_{\varepsilon}(\phi) + (I - u_{out})^2 (1 - H_{\varepsilon}(\phi)] d\mathbf{x}$$

Chan and Vese 2001

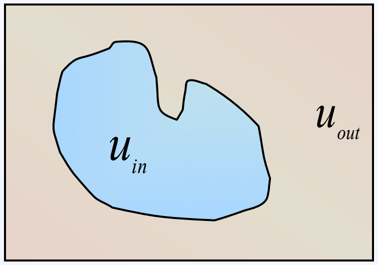
$$E(\phi, \mathbf{P}) = \int_{\Omega} \boxed{\text{Region based}} + \text{Smoothness} + \text{Edge based} + \text{Shape} \;\; d\mathbf{x}$$

Region-based Term

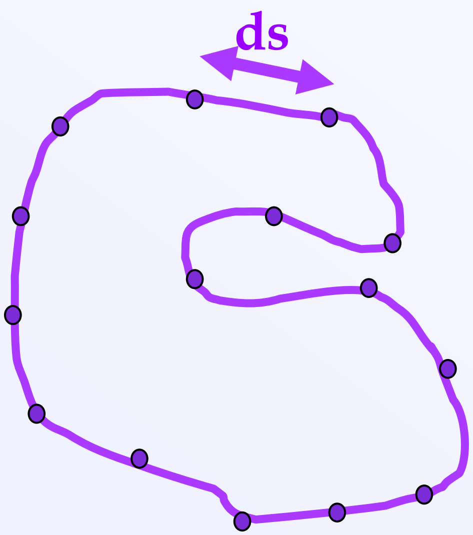
Chan-Vese Two Phase Model
Gradient descent equation (Euler Lagrange)

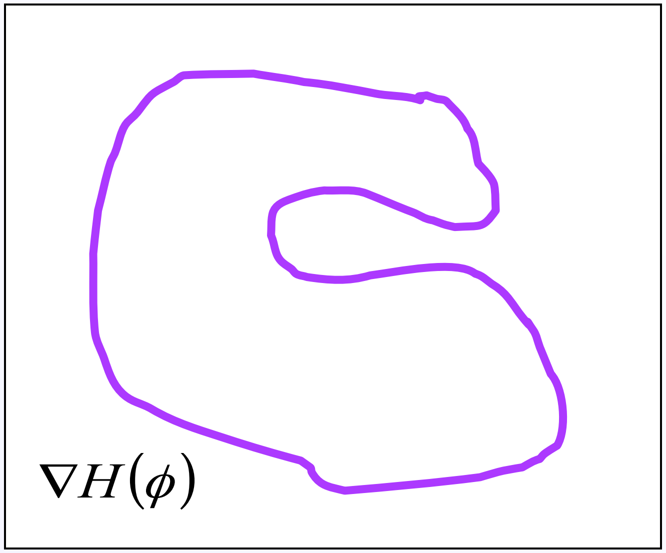
$$\frac{\partial \phi^{\mathrm{RB}}}{\partial t} = \delta_\varepsilon(\phi)\left[\left(I(\mathbf{x}) - u_{out}\right)^2 - \left(I(\mathbf{x}) - u_{in}\right)^2 \right]$$

$$u_{in} = \frac{\int I(\mathbf{x}) H_\varepsilon(\phi)\, d\mathbf{x}}{\int H_\varepsilon(\phi)\, d\mathbf{x}} \qquad u_{out} = \frac{\int I(\mathbf{x})\left(1 - H_\varepsilon(\phi)\right) d\mathbf{x}}{\int \left(1 - H_\varepsilon(\phi)\right) d\mathbf{x}}$$



Smoothness Term





$$|c| = \int_0^L ds \Longrightarrow E_{LEN} = \int_\Omega \underbrace{|\nabla H(\phi(\mathbf{x}))|\, d\mathbf{x}}_{ds}$$

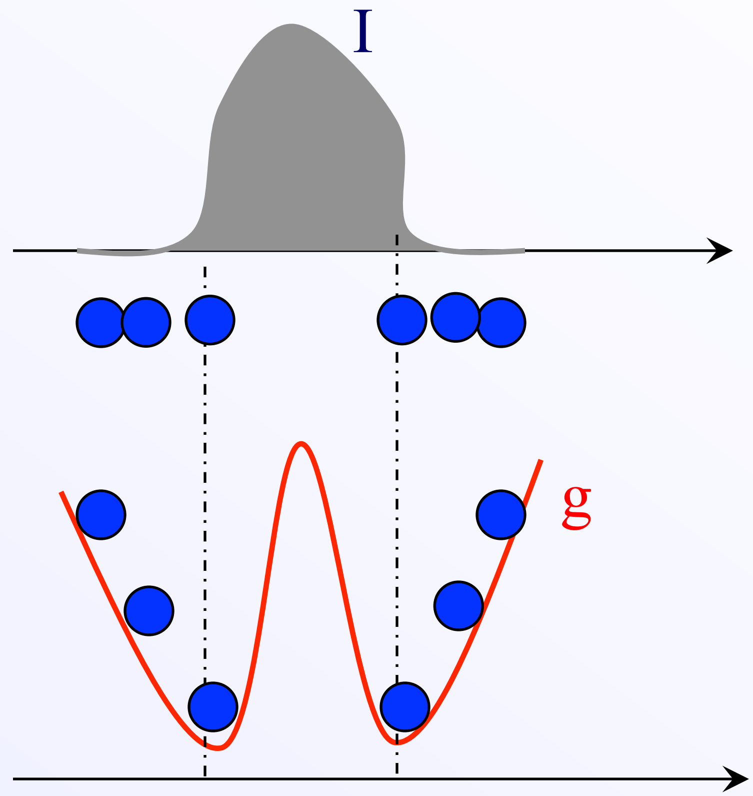
$$\phi_t^{LEN} = \delta_\varepsilon(\phi)\, div\left(\frac{\nabla\phi}{|\nabla\phi|}\right)$$

$$E(\phi, \mathbf{P}) = \int_\Omega \text{Region based} + \boxed{\text{Smoothness}} + \text{Edge based} + \text{Shape} \;\; d\mathbf{x}$$

Geodesic Active Contour

$$E_{GAC} = \int_C g(|\nabla I|)ds$$

$$g(\mathbf{x}) = \frac{1}{1 + |\nabla I(\mathbf{x})|^2}$$

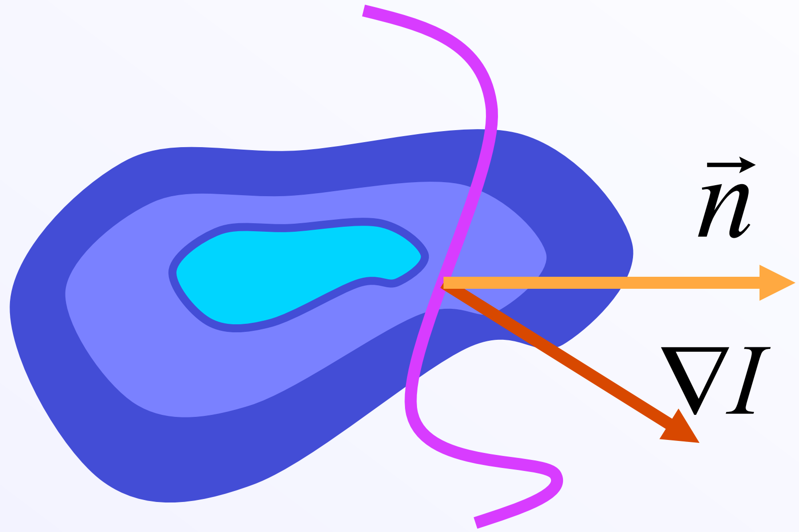


$$E_{\mathrm{GAC}} = \int_\Omega g(|\nabla I|)\underbrace{|\nabla H_\varepsilon(\phi(\mathbf{x}))|\, d\mathbf{x}}_{ds}$$

$$E(\phi, \mathbf{P}) = \int_\Omega \text{Region based} + \text{Smoothness} + \boxed{\text{Edge based}} + \text{Shape}\ \ d\mathbf{x}$$

Alignment Term

$$\vec{n} = \frac{\nabla\phi}{|\nabla\phi|}$$



$$E_{RA} = -\int_{\Omega} \left| \left\langle \nabla I, \frac{\nabla\phi}{|\nabla\phi|} \right\rangle \right| |\nabla H_{\varepsilon}(\phi)| \, d\mathbf{x}$$

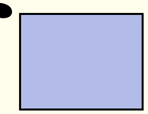
Talk Overview

- Level-sets formulation
  - Shape representation
  - Segmentation

- Prior based segmentation
- Mutual segmentation
- Symmetry based segmentation

Prior Shape Term

$$E_{\text{shape}}(\phi) = \int_{\Omega} \left(H_{\varepsilon}(\phi) - H_{\varepsilon}(\tilde{\phi}_{\mathbf{P}}) \right)^2 d\mathbf{x}$$

$D($  ,  $)$ =  $= \int_{\Omega}$ 

$I(\mathbf{x})$

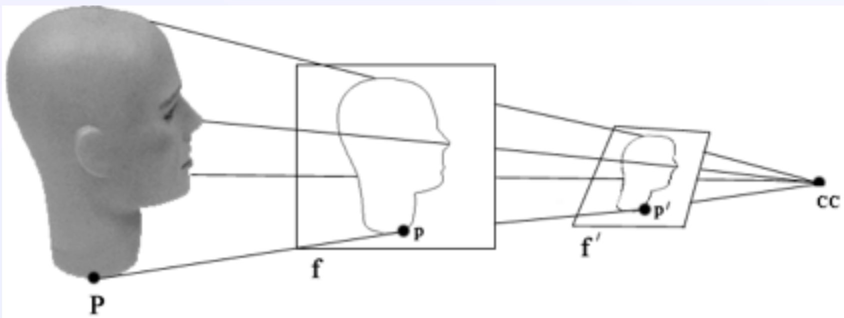
$\tilde{\chi}(\mathbf{x}) = H_{\varepsilon}\left(\tilde{\phi}(\mathbf{x})\right)$

$\tilde{\chi}(\mathbf{P}\,\mathbf{x}) = H_{\varepsilon}(\tilde{\phi}_{\mathbf{P}})$

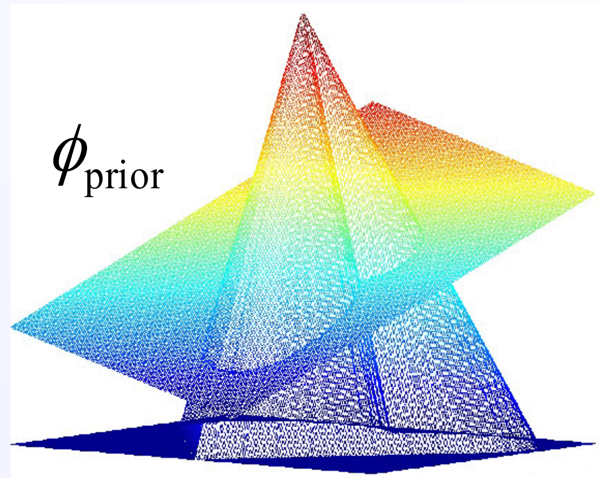
$E(\phi, \mathbf{P}) = \int_{\Omega}$ Region based + Smoothness+Edge based + Shape $d\mathbf{x}$

Representation of the Prior shape

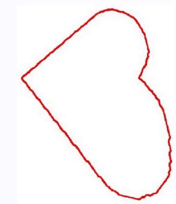
Single View Geometry

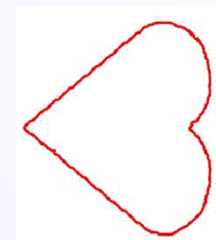


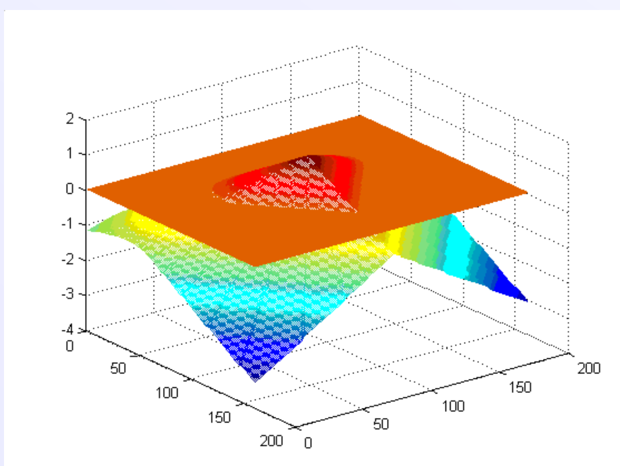
Cone of Rays

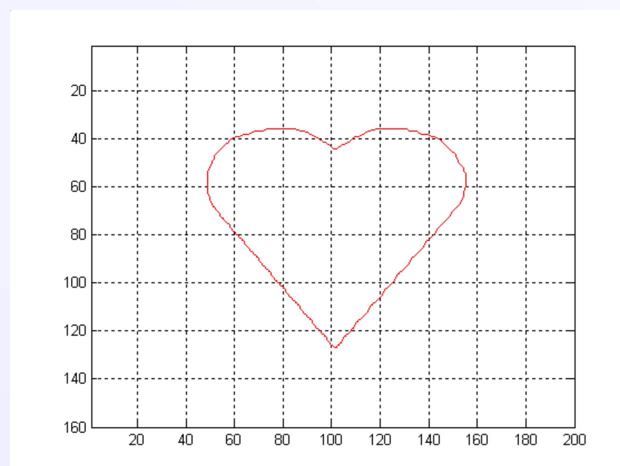


Generalized cone



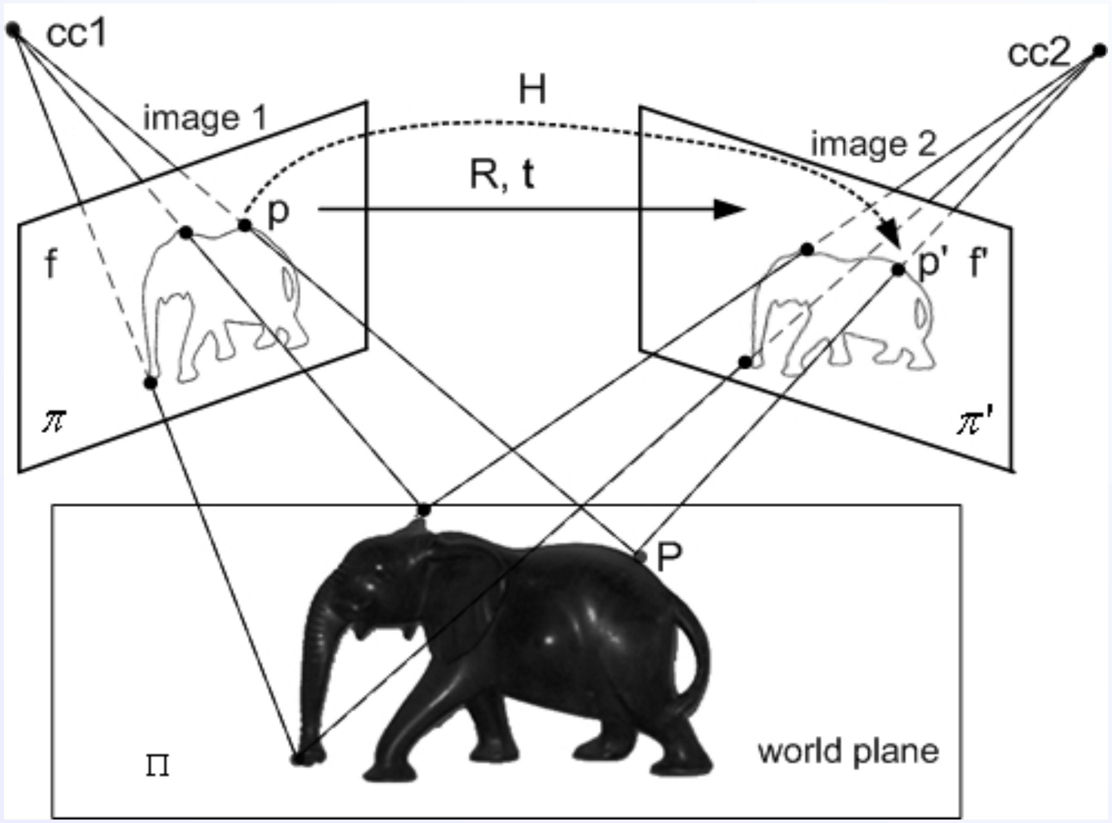






Representation of the Prior shape

Two View Geometry



The homography

$$\mathbf{x}' = \left(R + \frac{1}{d}\,\mathrm{tn}^{\mathrm{T}} \right)\mathbf{x} = \mathbf{P}\mathbf{x}$$

Gradient Descent Equations

$$E_{\text{shape}}(\phi) = \int_{\Omega} \Big(\underbrace{H_{\varepsilon}(\phi)}_{\chi} - \underbrace{H_{\varepsilon}(\tilde{\phi}_{\mathbf{P}})}_{\tilde{\chi}_{\mathbf{P}}} \Big)^{2} d\mathbf{x}$$

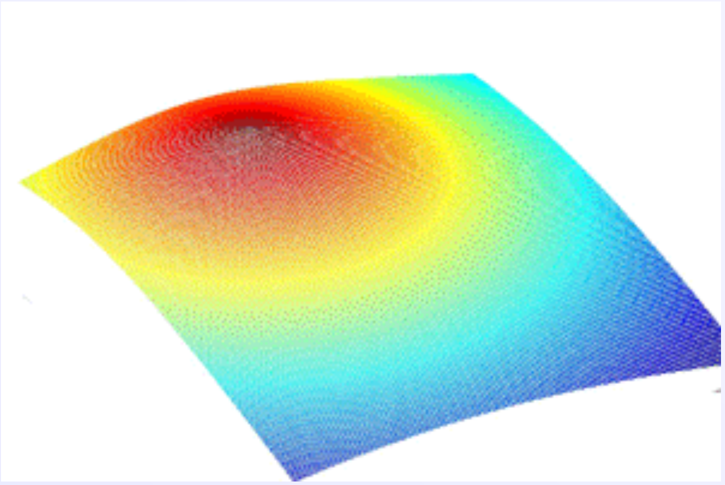
Gradient descent equations:

$$\frac{\partial \phi}{\partial t} = -2\delta_{\varepsilon}(\phi)\left[H_{\varepsilon}(\phi) - H_{\varepsilon}(\tilde{\phi}_{\mathbf{P}})\right]$$

$$\frac{\partial p_{ij}}{\partial t} = \int_{\Omega} \delta_{\varepsilon}\left(\tilde{\phi}_{\mathbf{P}}\right)\left[H_{\varepsilon}(\phi) - H_{\varepsilon}\left(\tilde{\phi}_{\mathbf{P}}\right)\right]\frac{\partial \tilde{\phi}_{\mathbf{P}}}{\partial p_{ij}}\, d\mathbf{x}$$

Unified Cost Functional

$$E(\phi, \mathbf{P}) = \int_{\Omega} \text{Region based} + \text{Smoothness} + \text{Edge based} + \text{Shape} \; d\mathbf{x}$$



Evolution of ϕ

Registration

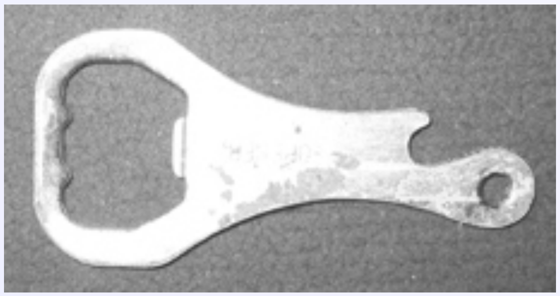
Results

Prior

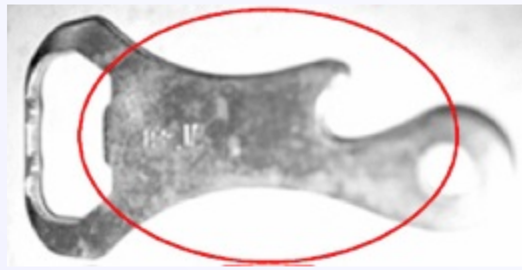
Segmentation

ECCV-04, ICCV05 Riklin-Raviv, Kiryati, Sochen

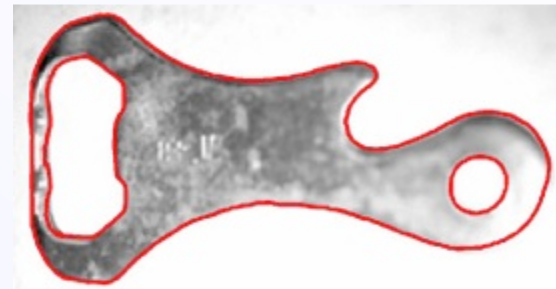
Results



Prior Image



Initial contour



Final (desired) segmentation

Verification:
Final contour on
transformed prior

Prior contour on image

Segmentation without prior

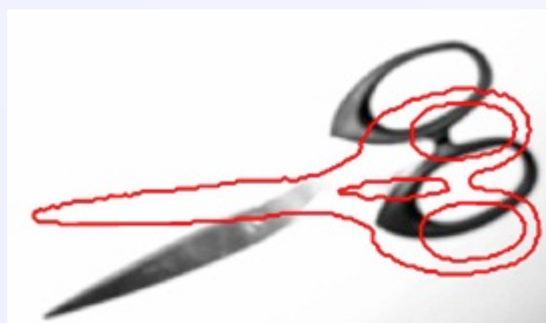
Results

Prior Image

Initial contour

Final (desired) segmentation

Verification:
Final contour on transformed prior



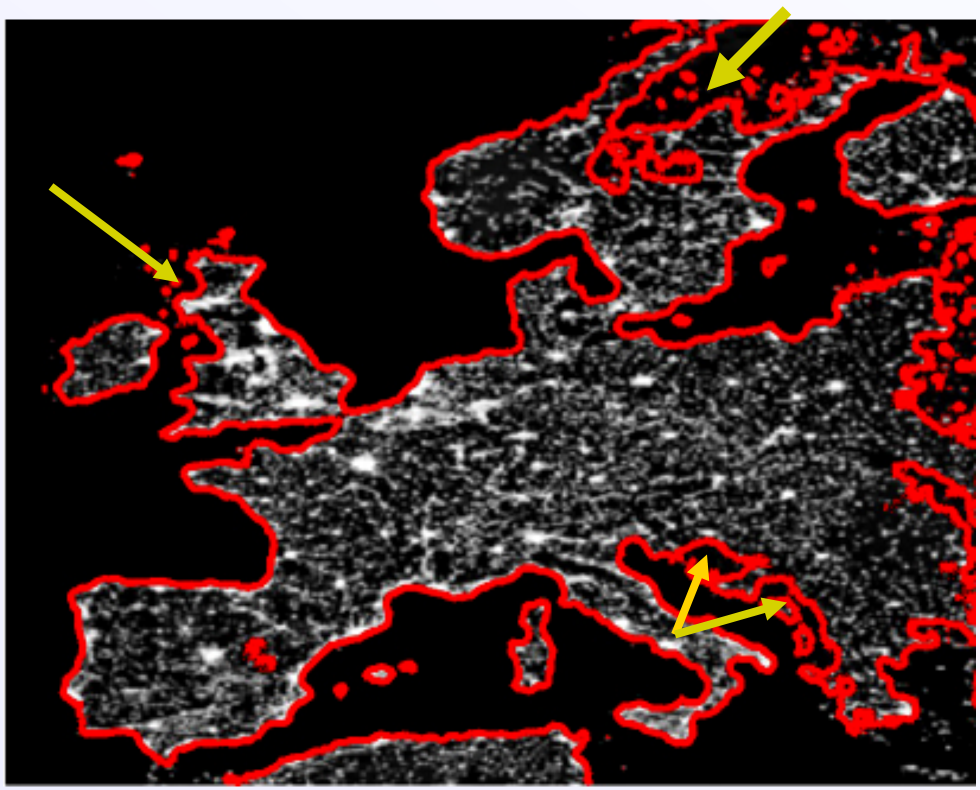
Prior contour on image

Segmentation without prior

Results

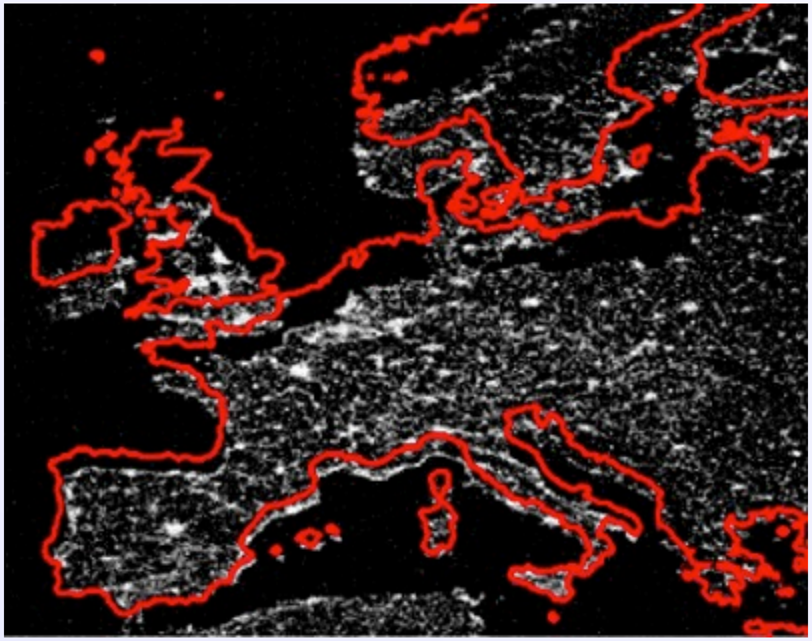
Image to segment

Results



Region based segmentation

Results



Misalignment

Prior image

Results

ICCV05 Riklin-Raviv, Kiryati, Sochen

Talk Overview

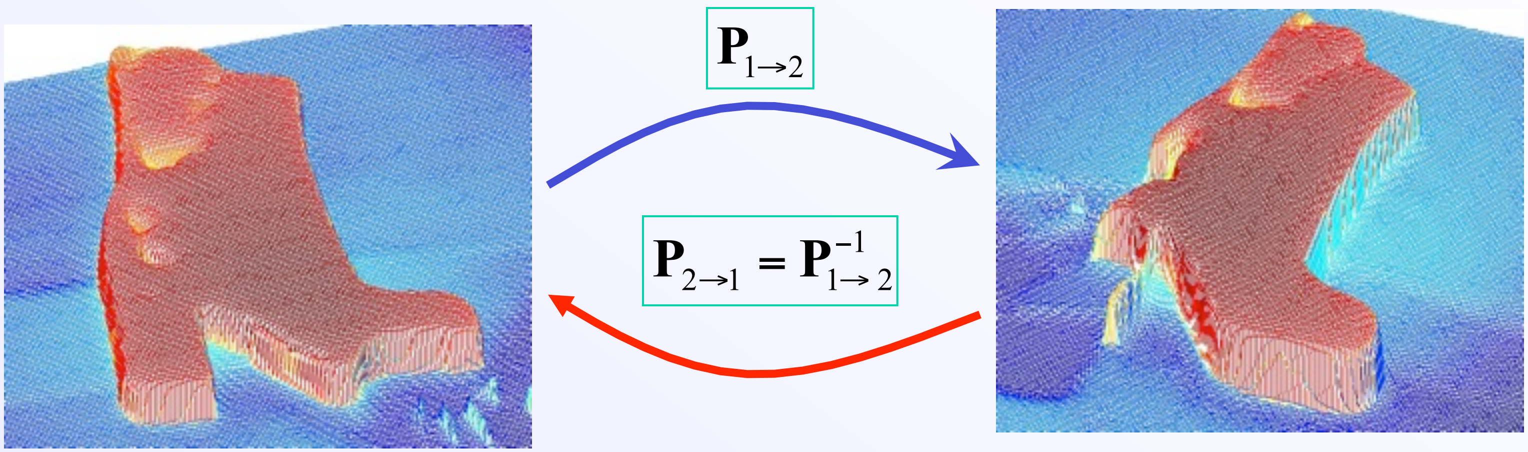
- Level-sets formulation
  - Shape representation
  - Segmentation
- Prior based segmentation

- <u>Mutual segmentation</u>
- Symmetry based segmentation

Problem setting

- Two views of the same object are given
- Their contours are related by planar projective transformation
- Each object cannot be segmented based on image data alone
- Together both images contain sufficient information for the extraction of the objects

Shape constraint



ϕ_1 ϕ_2

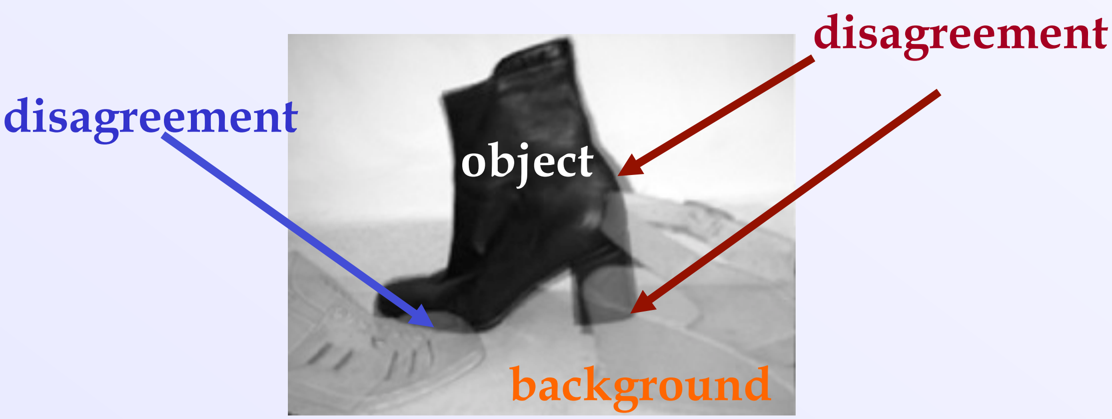
Alternately evolve the level set functions of the two object instances using both images data.

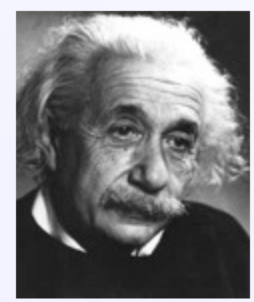
Evolve ϕ_1 based on the data of image I_1 and on ϕ_2 .

Evolve ϕ_2 based on the data of image I_2 and on ϕ_1 .

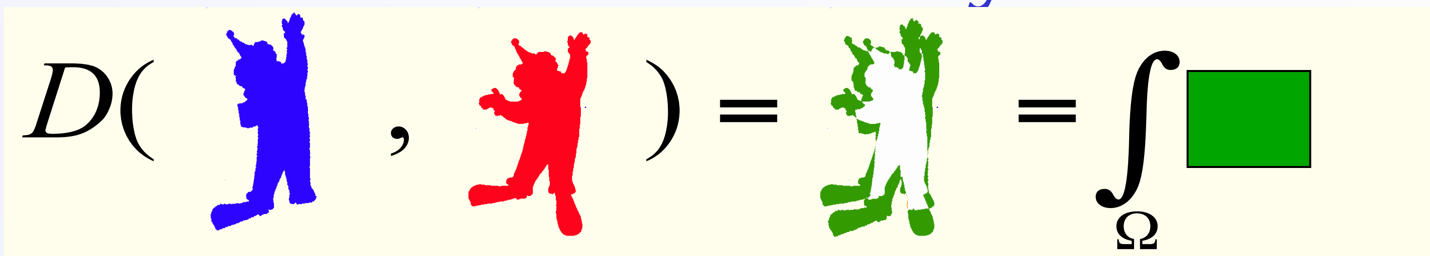
Oops ...

There is an inherent ambiguity in regions where the two object views disagree.





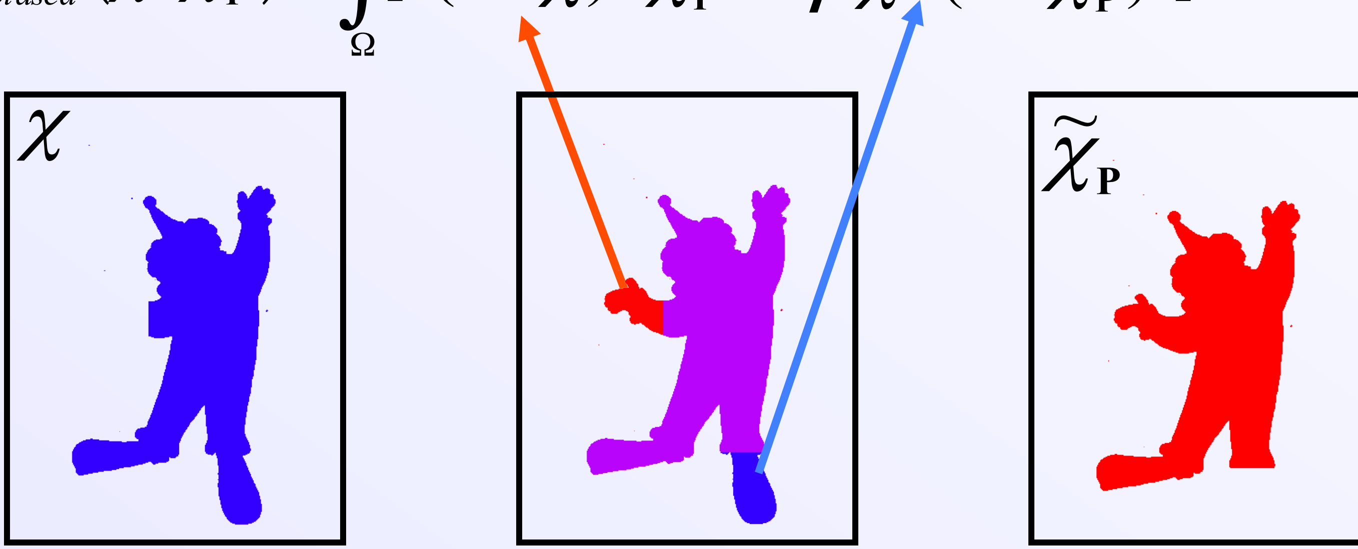
Biased dissimilarity measure



$$D(\chi,\tilde{\chi}_{\mathbf{P}}) = \int_{\Omega} (\chi(\mathbf{x}) - \tilde{\chi}_{\mathbf{P}}(\mathbf{x}))^2 \, d\mathbf{x} \cong \int_{\Omega} \chi(\mathbf{x}) \oplus \tilde{\chi}_{\mathbf{P}}(\mathbf{x}) \, d\mathbf{x}$$

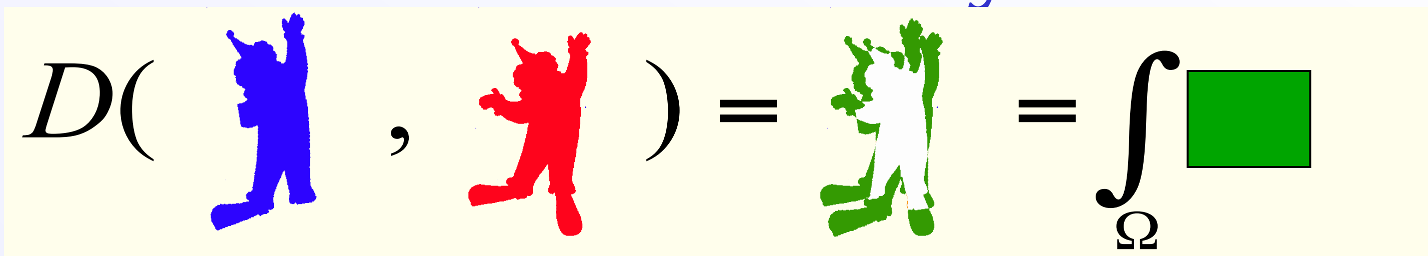
$$D_{biased}(\chi,\tilde{\chi}_{\mathbf{P}}) = \int_{\Omega} [\ (1-\chi)\cdot\tilde{\chi}_{\mathbf{P}} + \eta\ \chi\cdot(1-\tilde{\chi}_{\mathbf{P}})\ ]\, d\mathbf{x}$$

$0 < \eta < 1$



Currently evolved   Superposition   Aligned reference shape

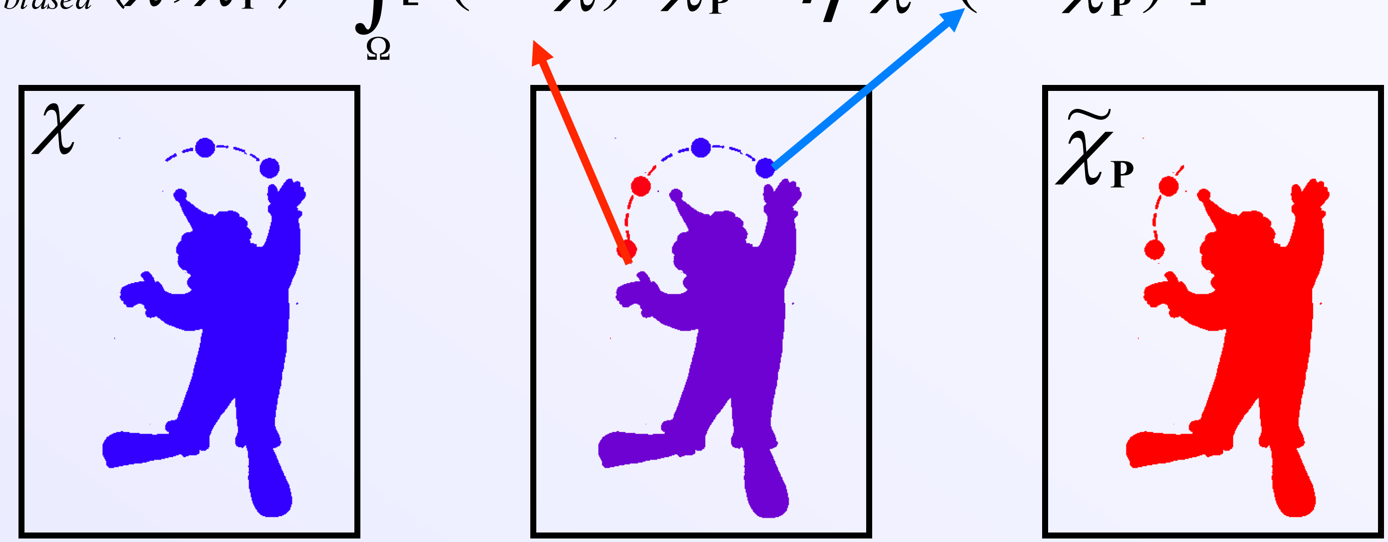
Biased dissimilarity measure



$$D(\chi,\tilde{\chi}_P) = \int_\Omega (\chi(\mathbf{x}) - \tilde{\chi}_P(\mathbf{x}))^2 \, d\mathbf{x} \cong \int_\Omega \chi(\mathbf{x}) \oplus \tilde{\chi}_P(\mathbf{x}) \, d\mathbf{x}$$

$$D_{biased}(\chi,\tilde{\chi}_P) = \int_\Omega [\ (1-\chi)\cdot\tilde{\chi}_P + \eta\ \chi\cdot(1-\tilde{\chi}_P)\ ]\, d\mathbf{x}$$

$$1 < \eta$$



Currently evolved   Superposition   Aligned reference shape

Unified Cost Functional

$$E(\phi, \mathbf{P}) = \int_{\Omega} \text{Region based} + \text{Edge based} + \text{Alignment} + \text{Shape} \quad d\mathbf{x}$$

$$E_{Shape}(\phi | \tilde{\phi}, \mathbf{P}) = \int_{\Omega} \left[\left(1 - H_{\varepsilon}(\phi)\right) H_{\varepsilon}(\tilde{\phi}_{\mathbf{P}}) + \eta H_{\varepsilon}(\phi) \left(1 - H_{\varepsilon}(\tilde{\phi}_{\mathbf{P}})\right) \right] d\mathbf{x}$$

$$\tilde{\phi}_{\mathbf{P}} = \tilde{\phi}(\mathbf{P}\mathbf{x})$$

The contribution of the shape term to ϕ

$$\phi_t^{Shape} = \delta_{\varepsilon}(\phi) [H(\tilde{\phi}_{\mathbf{P}}) - \eta \left(1 - H(\tilde{\phi}_{\mathbf{P}})\right)]$$

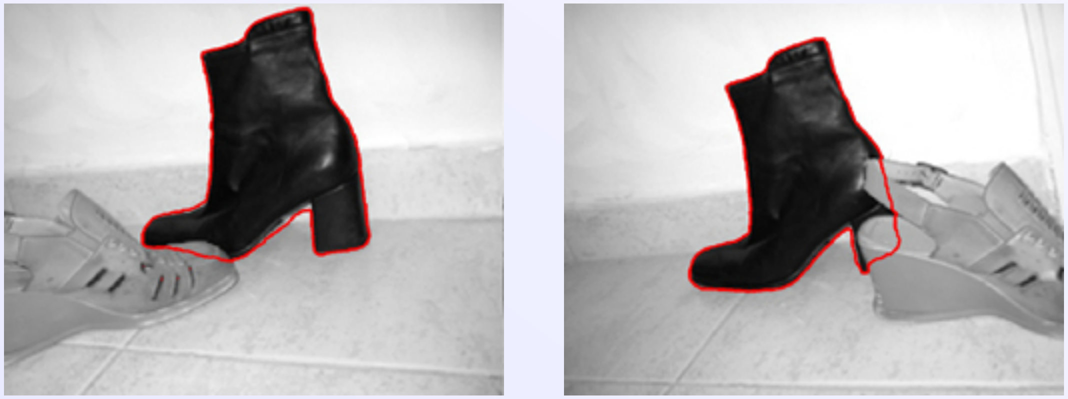
Recovery of the transformation parameters:

$$\frac{\partial p_{i,j}}{\partial t} = \int_{\Omega} \delta(\tilde{\phi}_{\mathbf{p}}) [\left(1 - H(\phi)\right) - \eta H(\phi)] \frac{\partial \tilde{\phi}_{\mathbf{P}}}{\partial p_{i,j}} d\mathbf{x}$$

Mutual Segmentation Results

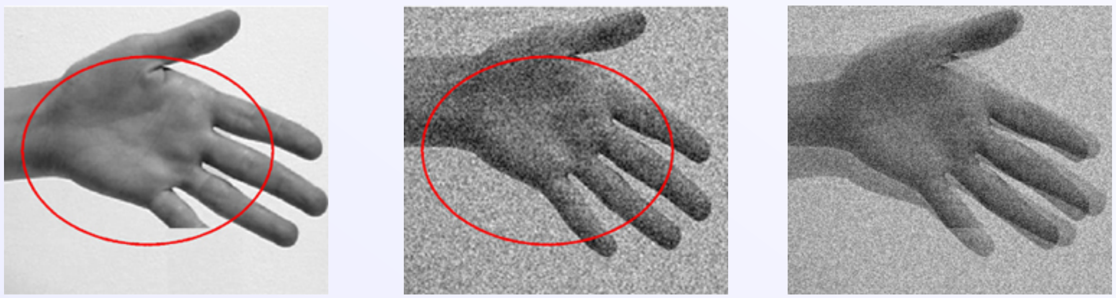
Initial contour

Superposition

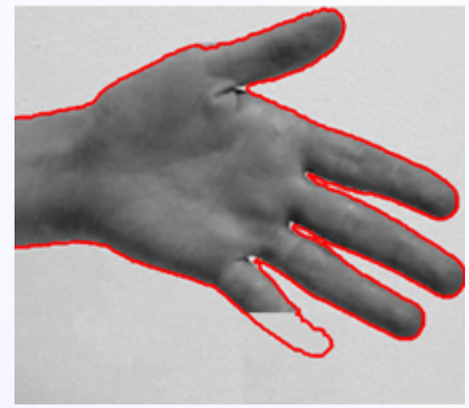


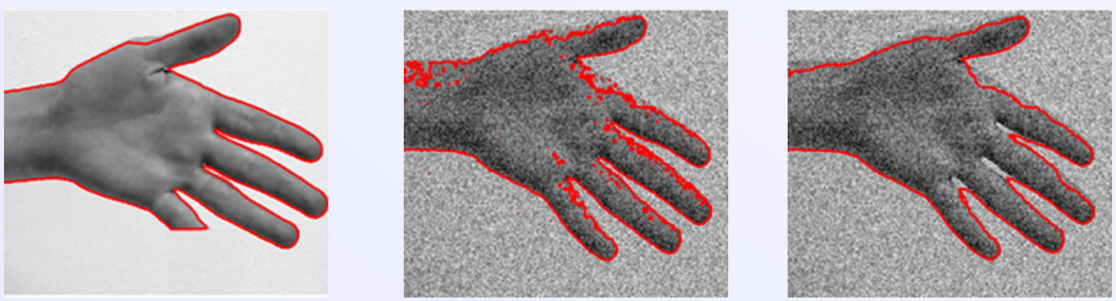
Mutual segmentation

Mutual Segmentation Results

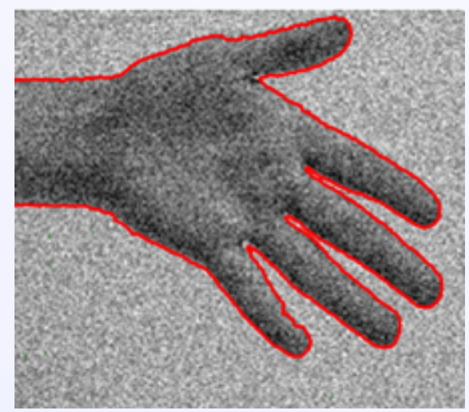


Initial contour Superposition





Self segmentation



Mutual segmentation

Mutual Segmentation Results

Initial contour

Initial contour

Superposition

Mutual segmentation

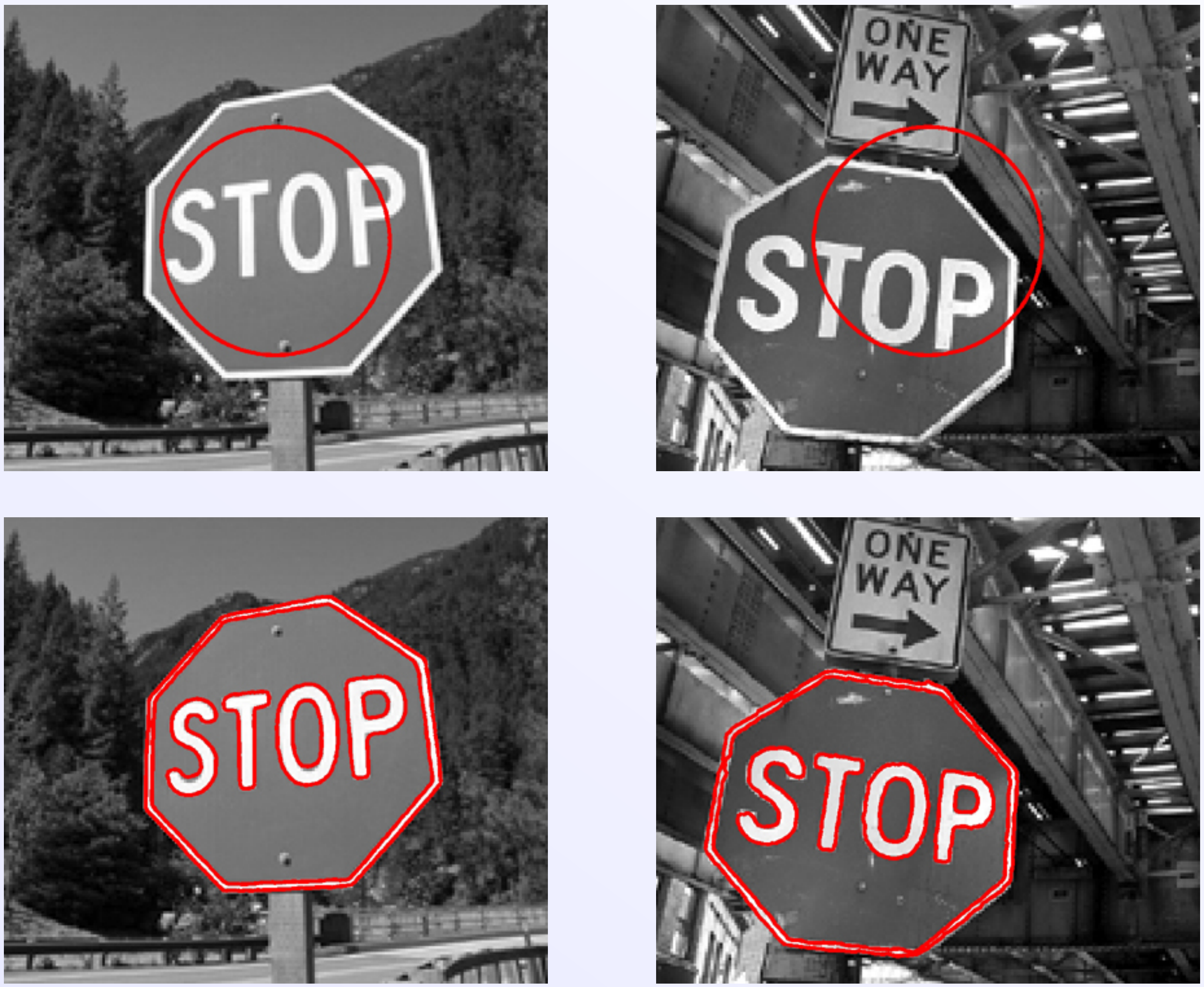
Mutual segmentation

Mutual Segmentation Results

Mutual segmentation

Self segmentation

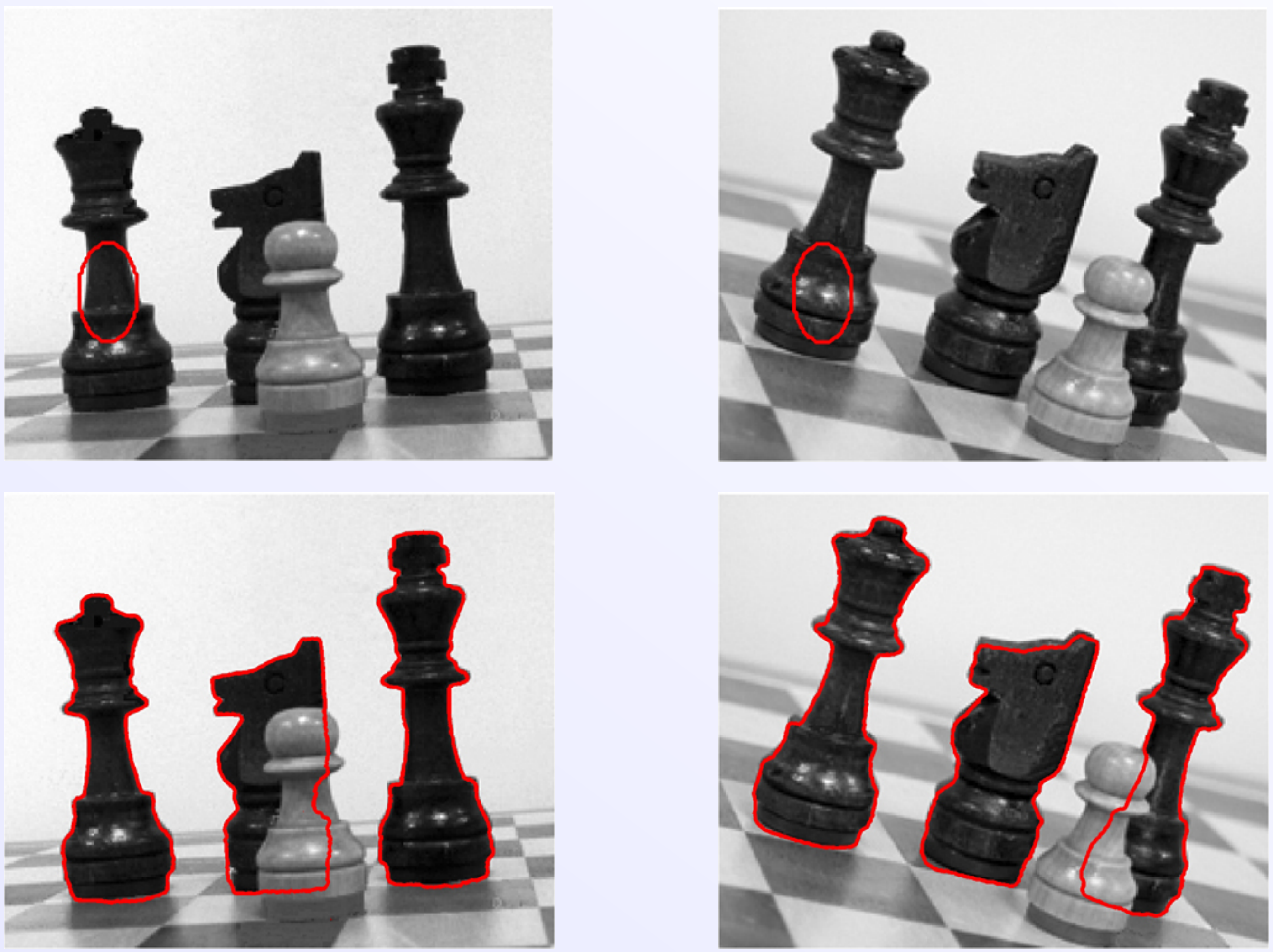
Mutual Segmentation: Results



Initial contour

Final contour

Mutual Segmentation: Results



Initial contour

Final contour

Talk Overview

- Level-sets formulation
  - Shape representation
  - Segmentation
- Prior based segmentation
- Mutual segmentation

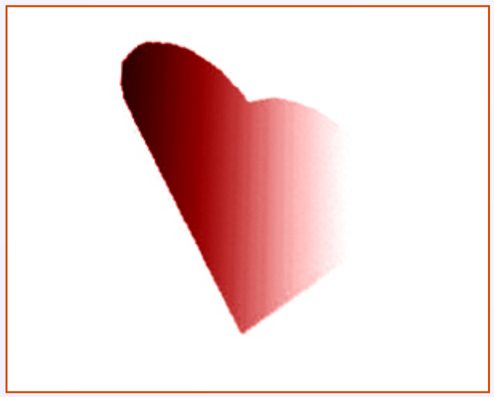
- Symmetry based segmentation

Shape Symmetry

The Prior is Inside

Symmetry as Shape Constraint

Image to segment



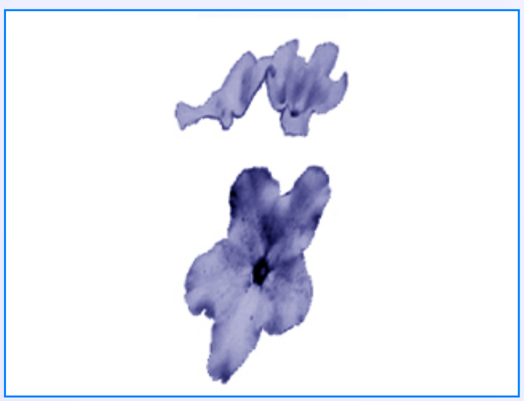
Symmetrical counterpart

Registration

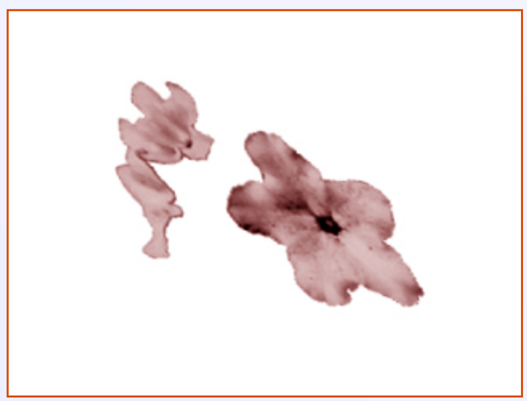
Symmetry as Shape Constraint

Original image

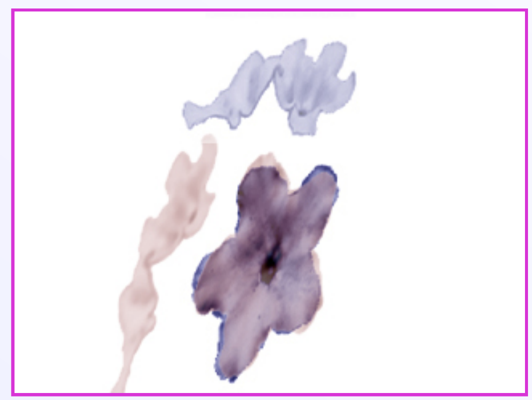
Color-based segmentation



Distorted segmentation

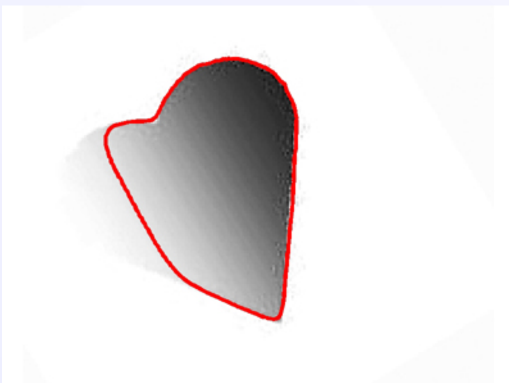


Symmetrical counterpart

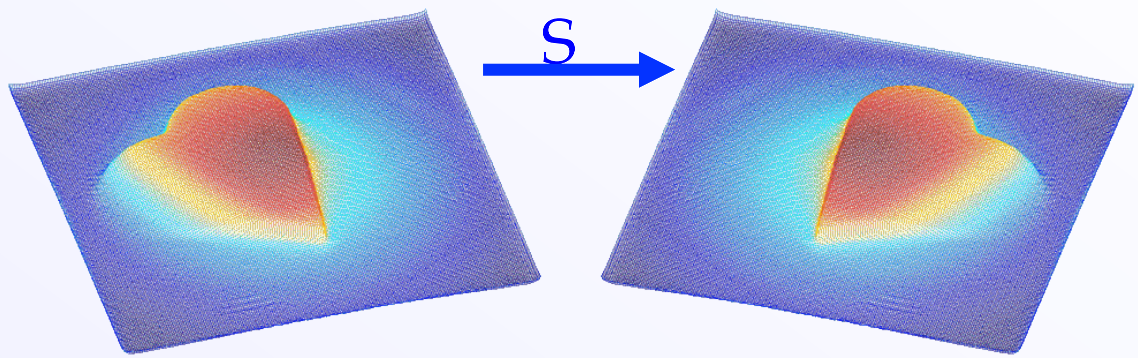


Registration

Symmetrical Counterparts



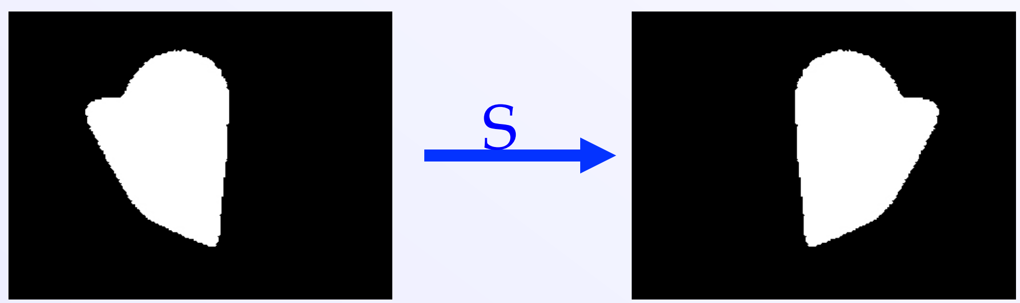
Segmentation



Evolving level-set function $\phi(t)$

Symmetrical counterpart $\hat{\phi}(t)$

χ is symmetrical when $\chi = \hat{\chi}$



$\chi(\mathbf{x}) = H_\varepsilon(\phi(\mathbf{x}))$

$\hat{\chi}(\mathbf{x}) = H_\varepsilon(\phi(S\mathbf{x}))$

Symmetry Matrices

$$S_{LR} = \begin{bmatrix} -1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \qquad S_{UD} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

Reflection

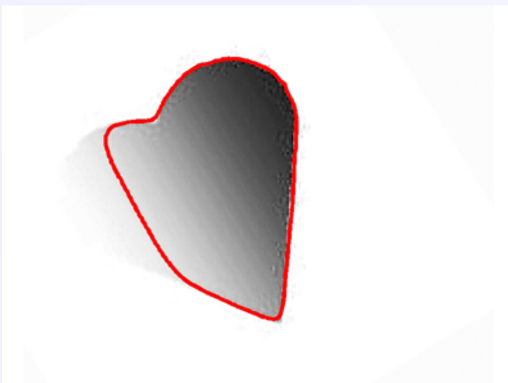
$$S_{ROT} = \begin{bmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

Rotation

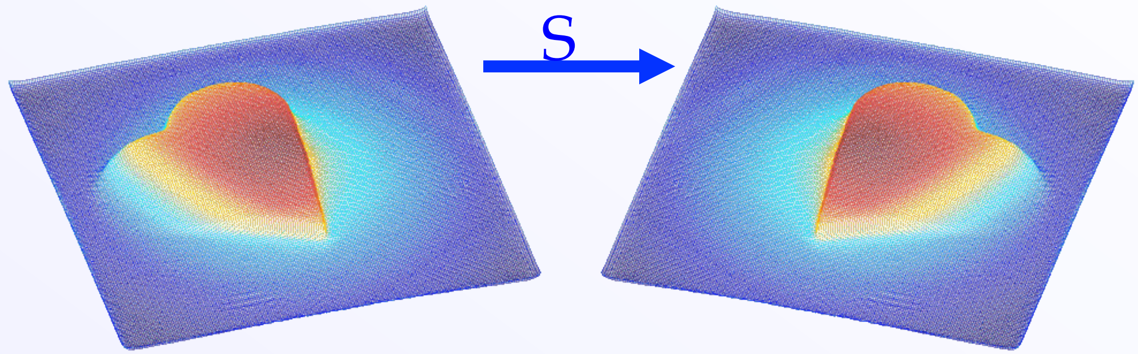
$$S_{Tx} = \begin{bmatrix} 1 & 0 & t_x \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \qquad S_{Ty} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & t_y \\ 0 & 0 & 1 \end{bmatrix}$$

Translation

Symmetrical Counterparts



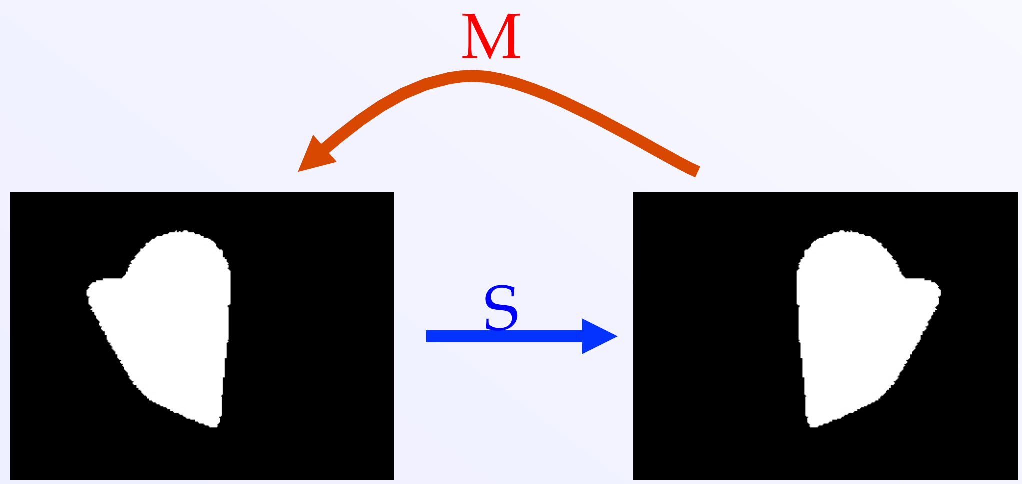
Segmentation



Evolving level-set function $\phi(t)$

Symmetrical counterpart $\hat{\phi}(t)$

M is a planar projective Homography.



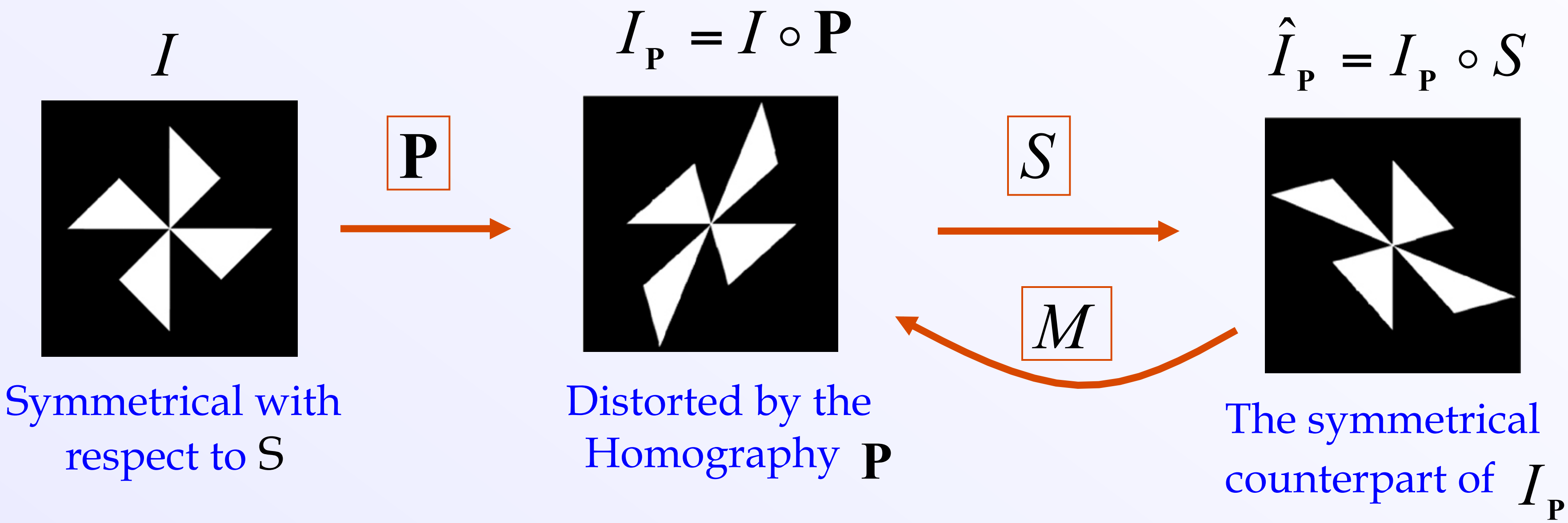
$\chi(\mathbf{x}) = H_{\varepsilon}(\phi(\mathbf{x}))$

$\hat{\chi}(\mathbf{x}) = H_{\varepsilon}(\phi(S\mathbf{x}))$

S is a 3×3 matrix.

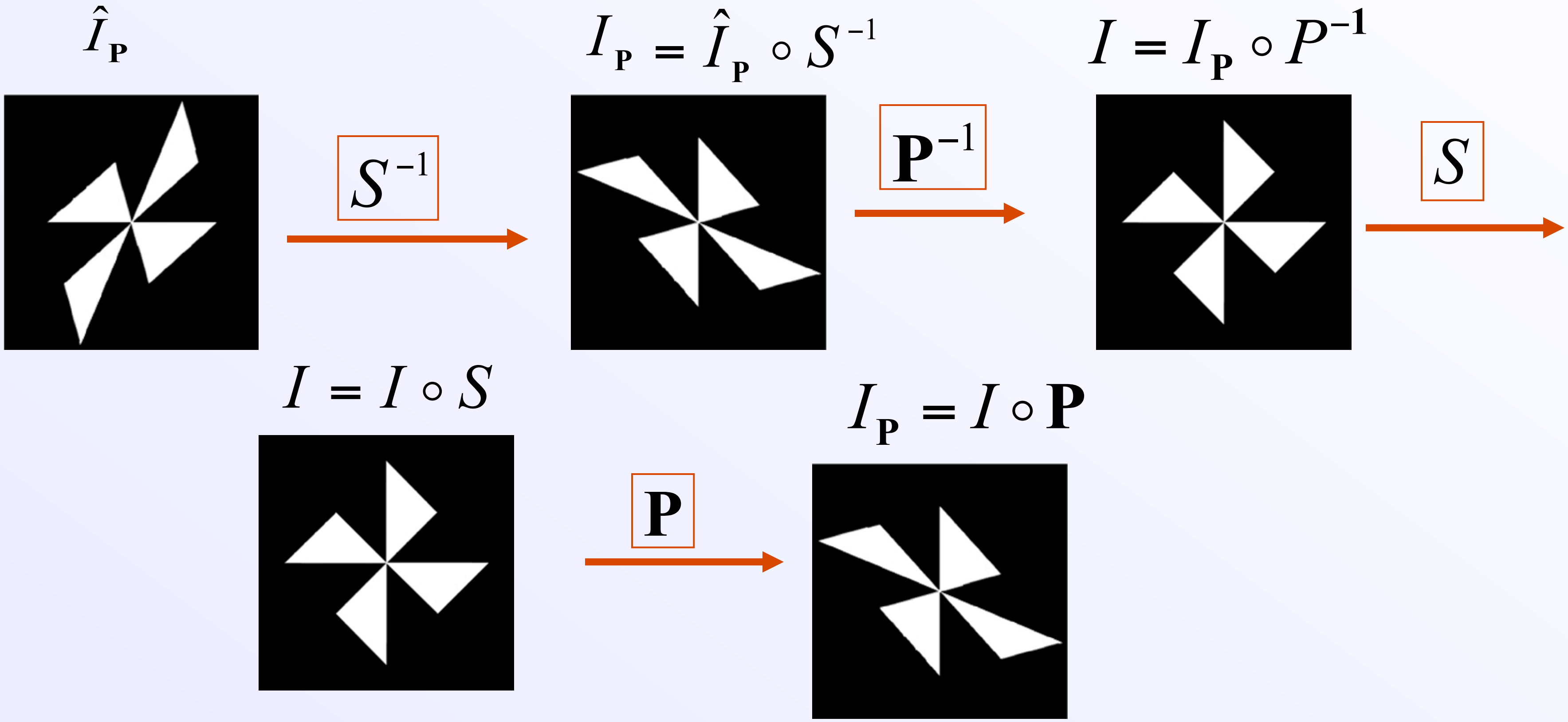
Theoretical Results:

The Recovery of P from M



$$M = S^{-1}\mathbf{P}^{-1}S\,\mathbf{P}$$

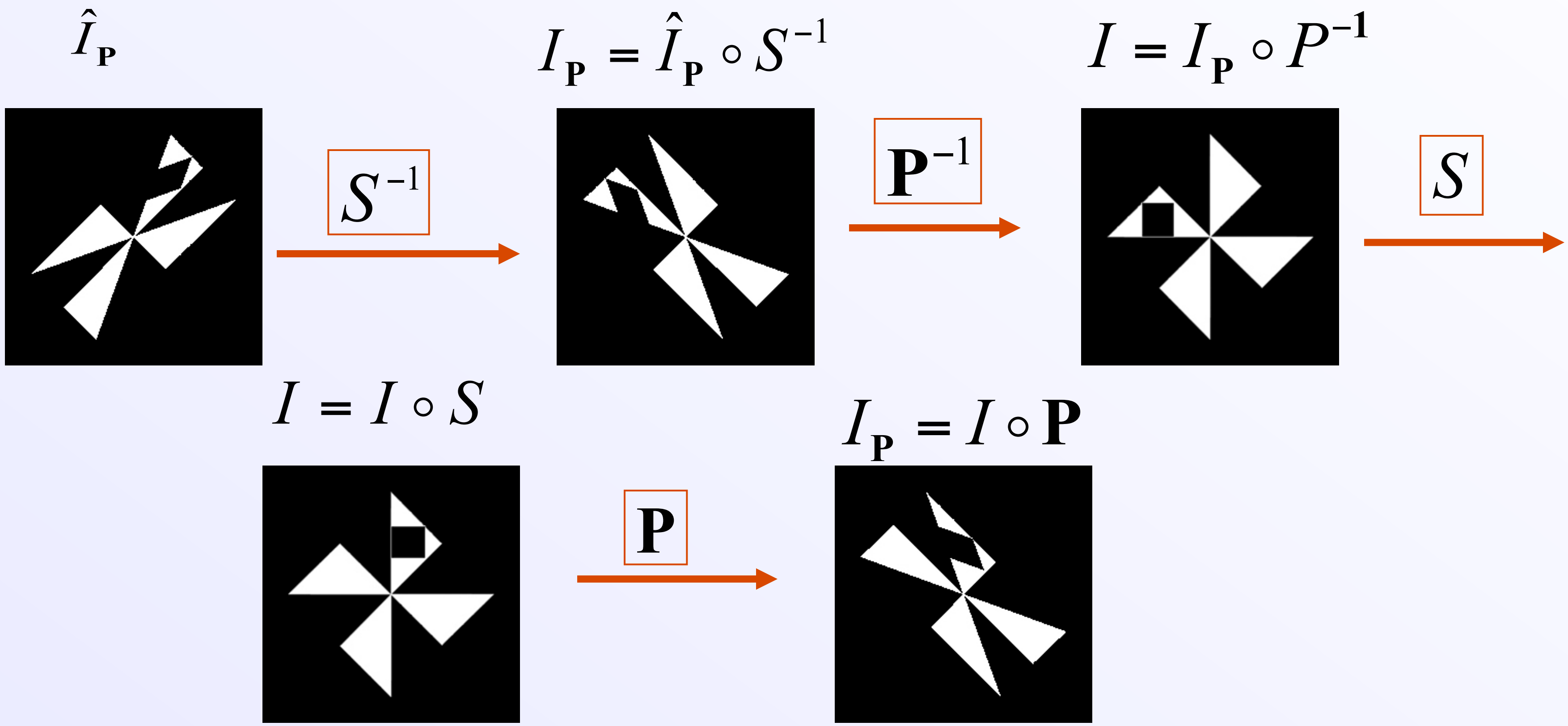
The Transformation between Symmetrical Counterparts



$$S_{\mathbf{P}} = \mathbf{P}^{-1} S \mathbf{P} = \mathbf{P}^{-1} S^{-1} \mathbf{P}$$

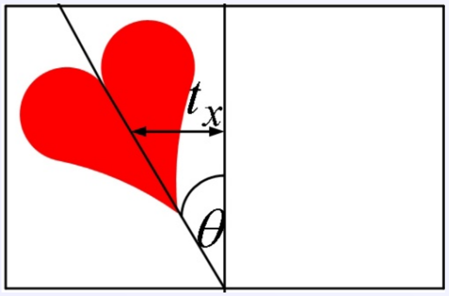
$$M = S^{-1} S_{\mathbf{P}} = S^{-1} \mathbf{P}^{-1} S \mathbf{P}$$

The Transformation between Symmetrical Counterparts

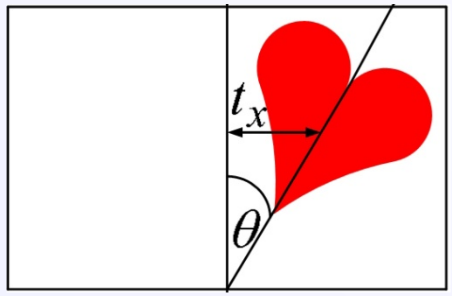


$$M = S^{-1}\mathbf{P}^{-1}S\,\mathbf{P}$$

Examples



$I_{\mathbf{P}_E}$



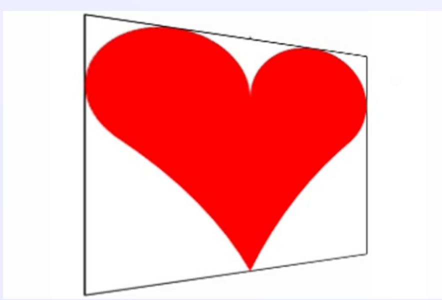
$\hat{I}_{\mathbf{P}_E}$

$$S = \begin{bmatrix} -1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$\mathbf{P}_{\mathrm{E}} = \begin{bmatrix} R(\theta) & \mathbf{t} \\ 0 & 1 \end{bmatrix}$$

$$M = \begin{bmatrix} R(2\theta) & \tilde{\mathbf{t}} \\ 0 & 1 \end{bmatrix}$$

$$\tilde{\mathbf{t}} = 2R(\theta)\begin{bmatrix} t_x \\ 0 \end{bmatrix}$$



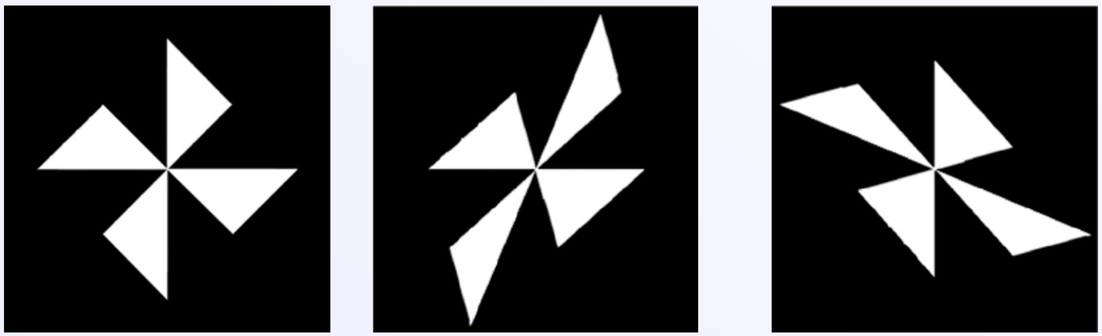
$I_{\mathbf{P}}$

$\hat{I}_{\mathbf{P}}$

$$\mathbf{P} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ v_1 & v_2 & 1 \end{bmatrix}$$

$$M = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 2v_1 & 0 & 1 \end{bmatrix}$$

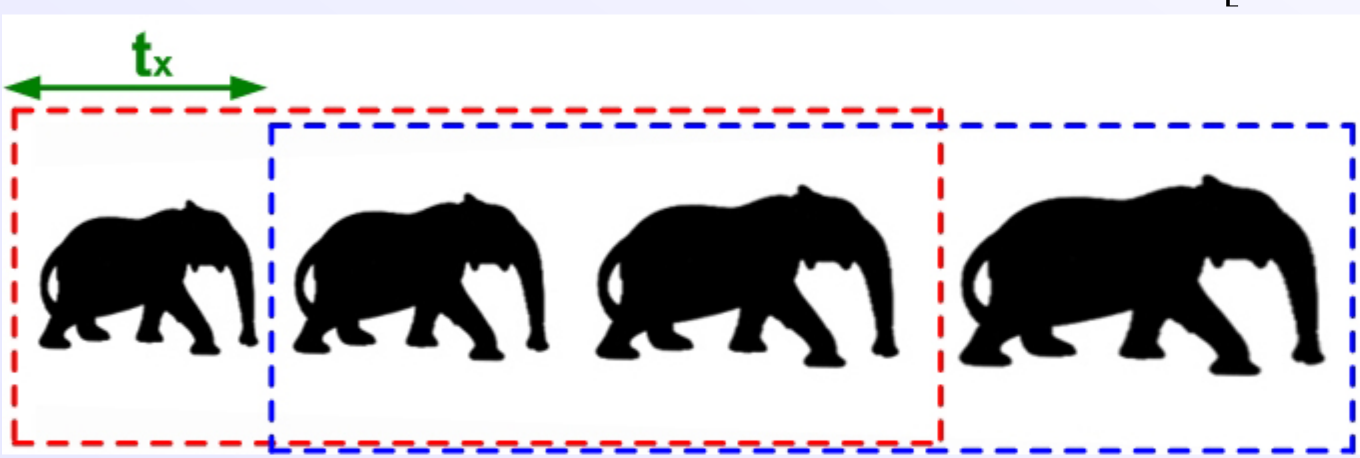
Examples



$$S = \begin{bmatrix} 0 & -1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

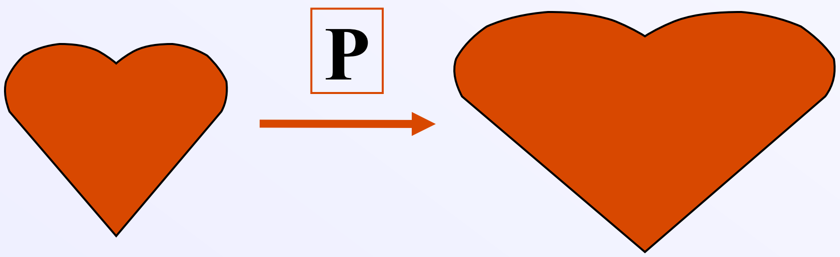
Rotation by $\pi / 2$

$$\mathrm{H} = \begin{bmatrix} R(\theta) & \mathbf{0} \\ \mathbf{0}^T & 1 \end{bmatrix} \begin{bmatrix} K & \mathbf{0} \\ \mathbf{0}^T & 1 \end{bmatrix} \qquad K = \begin{bmatrix} k_1 & k_2 \\ 0 & 1/k_1 \end{bmatrix} \qquad M = \begin{bmatrix} k_1^2 & k_1 k_2 & 0 \\ k_1 k_2 & 1/k_1^2 + k_2^2 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$



Limits on the Recovery of P from M

$\mathbf{P}$ is symmetry preserving if $I(\mathbf{P}S\mathbf{X}) = I(S\mathbf{P}\mathbf{X})$



$\mathbf{P}$ cannot be recovered from M if $\mathbf{P} = \mathbf{P}^{*}\tilde{\mathbf{P}}$
and $\mathbf{P}^{*}$ is a symmetry preserving transformation.

$$M = S^{-1}\mathbf{P}^{-1}S\mathbf{P} = S^{-1}(\mathbf{P}^{*}\tilde{\mathbf{P}})^{-1}S(\mathbf{P}^{*}\tilde{\mathbf{P}}) = S^{-1}\tilde{\mathbf{P}}^{-1}\mathbf{P}^{*-1}S\mathbf{P}^{*}\tilde{\mathbf{P}} =$$

$$S^{-1}\tilde{\mathbf{P}}^{-1}\mathbf{P}^{*-1}\mathbf{P}^{*}S\tilde{\mathbf{P}} = S^{-1}\tilde{\mathbf{P}}^{-1}S\tilde{\mathbf{P}}$$

Unified Cost Functional

$$E(\phi, \mathbf{M}) = \int_{\Omega} \text{Region based} + \text{Edge based} + \text{Smoothness} + \text{Symmetry} \, d\mathbf{x}$$

$$E_{Symmetry}(\phi, M) = H_{\varepsilon}(\phi)(1 - H_{\varepsilon}(\hat{\phi}_M)) + \eta H_{\varepsilon}(\hat{\phi}_M)\big(1 - H_{\varepsilon}(\phi)\big)$$

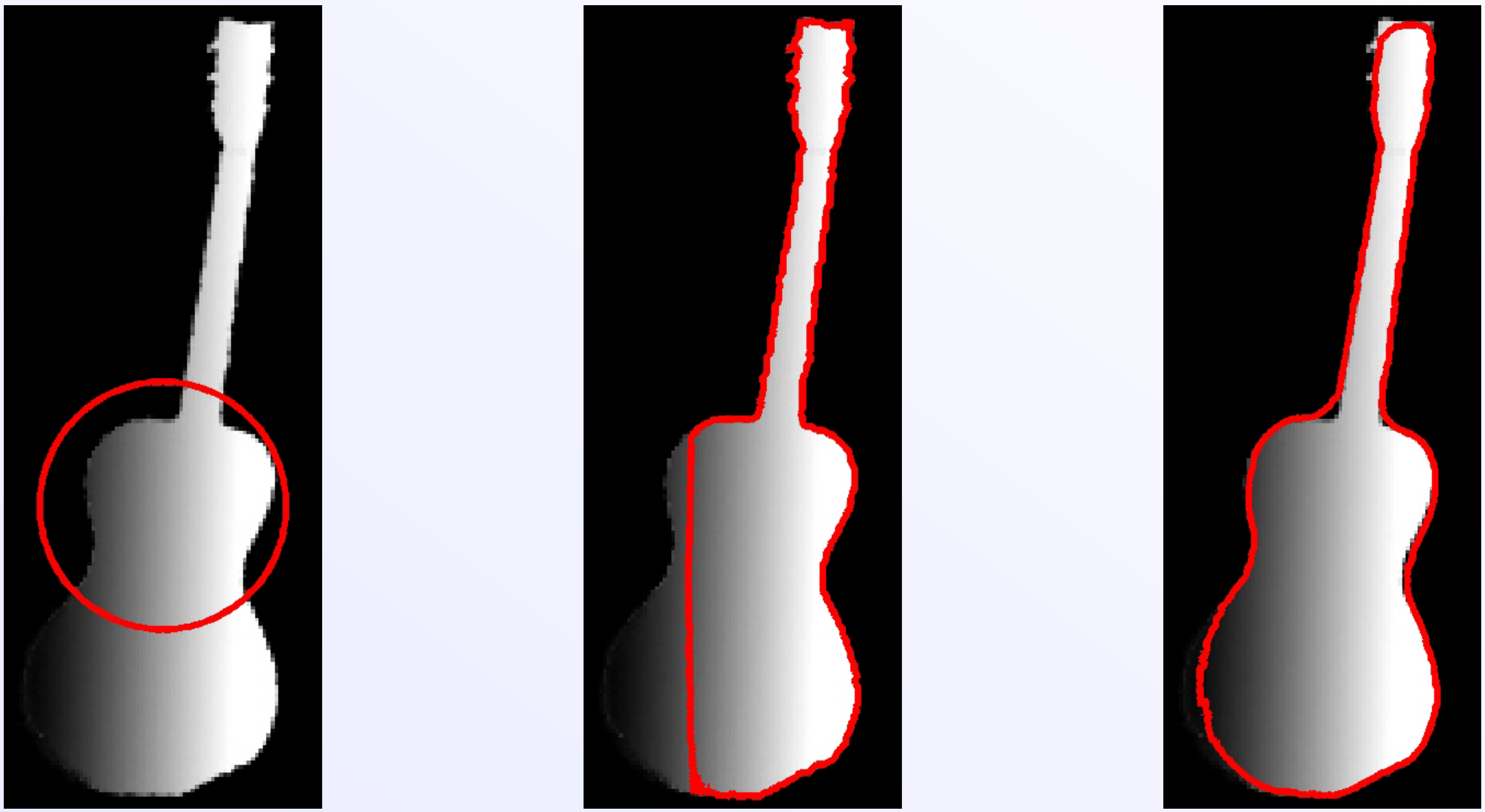
The contribution of the symmetry term to ϕ

$$\phi_t = \delta_{\varepsilon}(\phi) = [H_{\varepsilon}(\hat{\phi}_M) - \eta(1 - H_{\varepsilon}(\hat{\phi}_M))]$$

Gradient descent equations for M

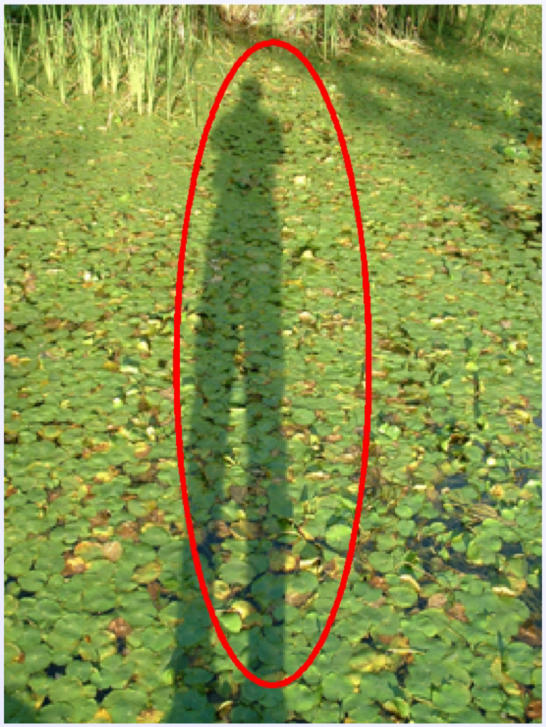
$$\frac{\partial m_{i,j}}{\partial t} = \int_{\Omega} \delta_{\varepsilon}(\hat{\phi}_M)[(1 - H_{\varepsilon}(\phi)) - \eta H_{\varepsilon}(\phi)] \frac{\partial \hat{\phi}_M}{\partial m_{i,j}} d\mathbf{x}$$

Symmetry Results

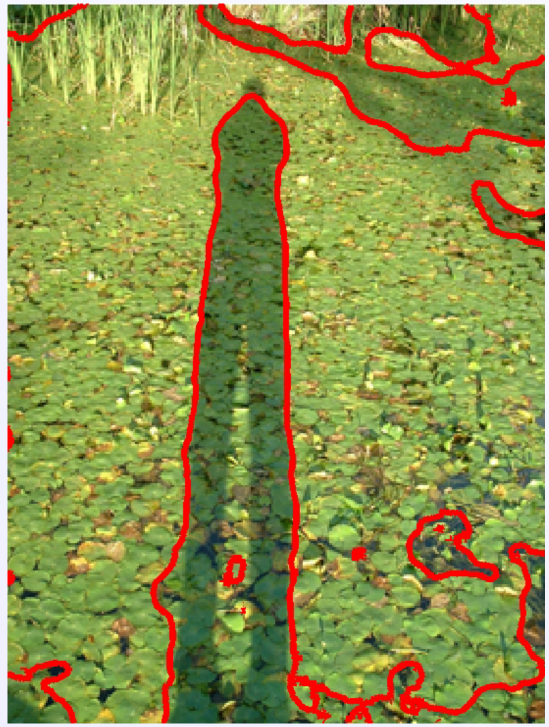


Initial contour | Region-Edge based segmentation | Symmetry-aided segmentation

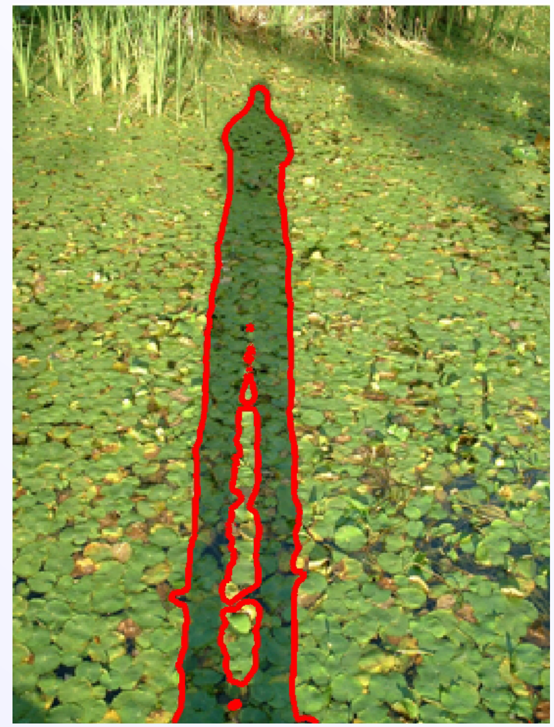
Symmetry Results



Initial contour



Region-Edge based segmentation



Symmetry-aided segmentation

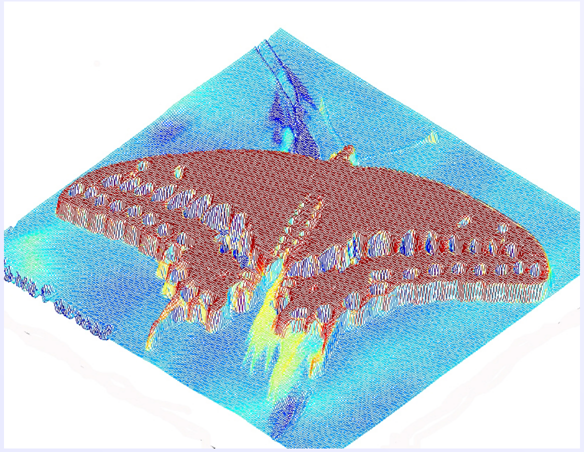
Original image courtesy of Amit Jayant Deshpande

Symmetry Results

Initial contour

Region-Edge based segmentation

Symmetry-aided segmentation

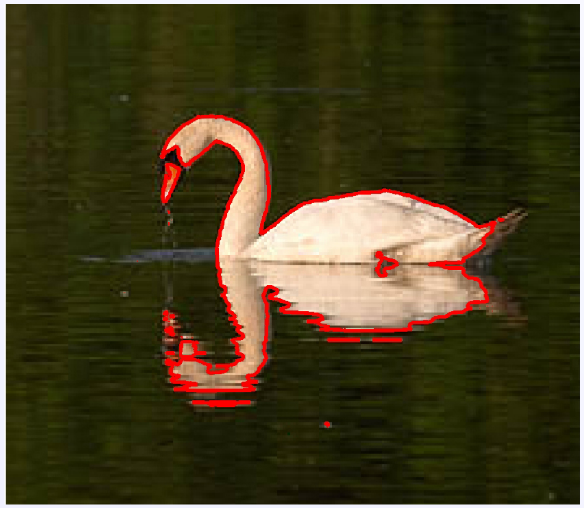


Final level-set function

Original image courtesy of George Payne

Symmetry Results

Initial contour



Region-Edge based segmentation

Symmetry-aided segmentation

Original image courtesy of Richard Lindley

Symmetry Results

Symmetry-aided segmentation

Original image courtesy of Kenneth R. Robertson

Symmetry Results

Initial contour

Region-Edge based segmentation

Symmetry-aided
Segmentation: 1 symmetrical counterpart

Symmetry-aided
Segmentation: 2 symmetrical counterparts

Symmetry Results

Region-Edge based segmentation

Symmetry-aided

Original image courtesy of Allen Matheson

Summary

Segmentation using a prior shape in the presence of perspective distortion

Mutual segmentation of two object views

Supporting segmentation by perspectively distorted symmetry

Thank you ☺