

Label Space

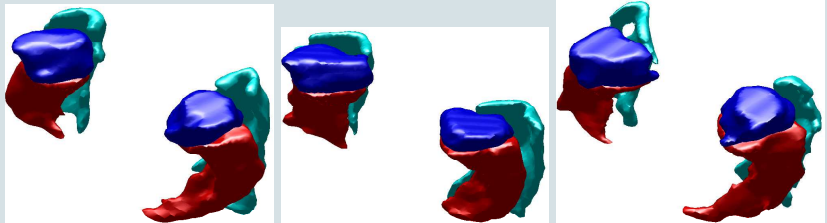
A Coupled Multi-Shape Representation

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Martha E. Shenton²

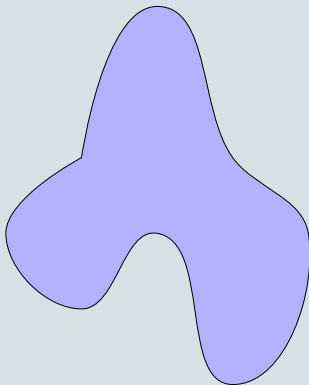
Yogesh Rathi²
Allen Tannenbaum¹

Georgia Tech, Atlanta, GA
Brigham and Women's Hospital, Boston, MA

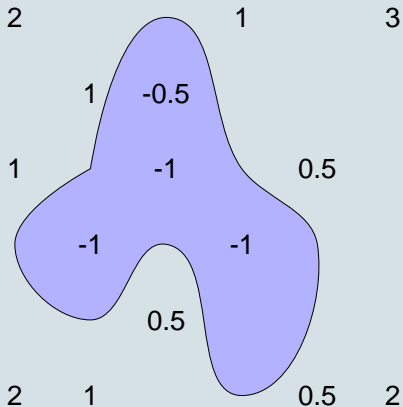




Implicit maps

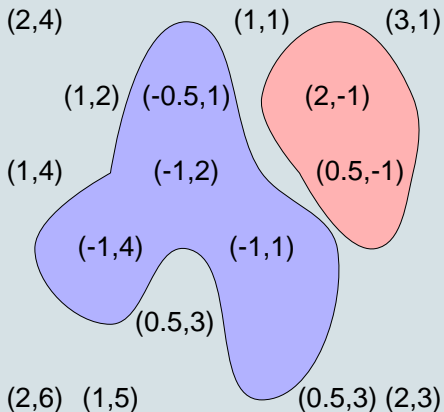


Signed distance maps (SDMs)



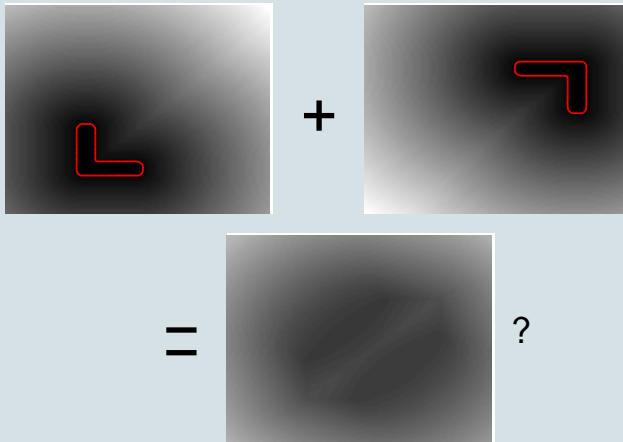
[Leventon et al. CVPR 2000]

Layered signed distance maps

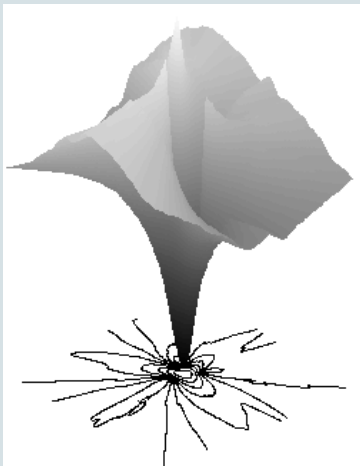
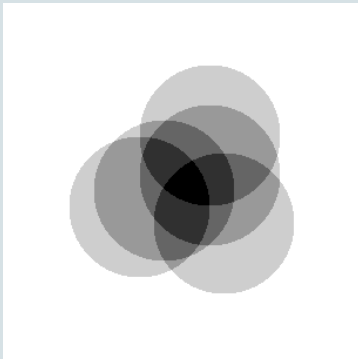


[Tsai et al. MIA, TMI 2003], [El Munim and Farag CVPR 2007]

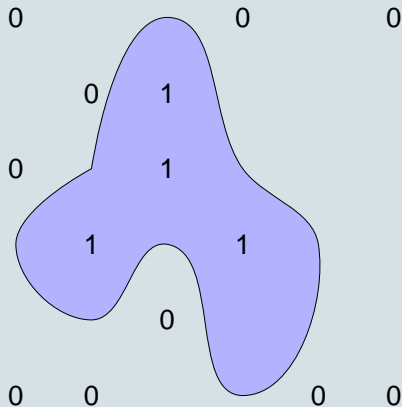
SDM Addition



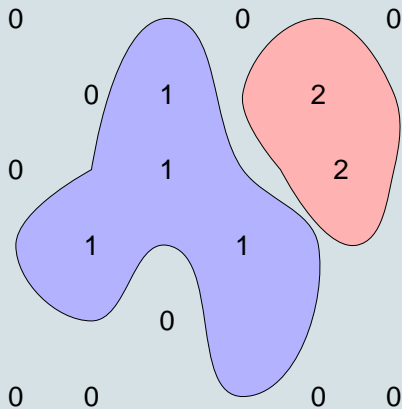
SDM Variation



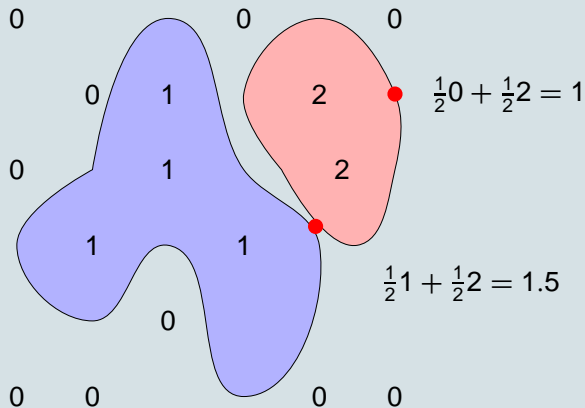
Label maps



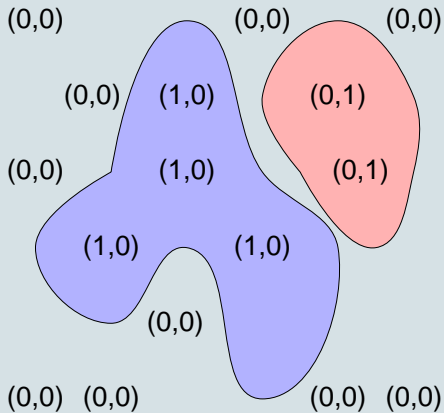
Label maps



Label maps

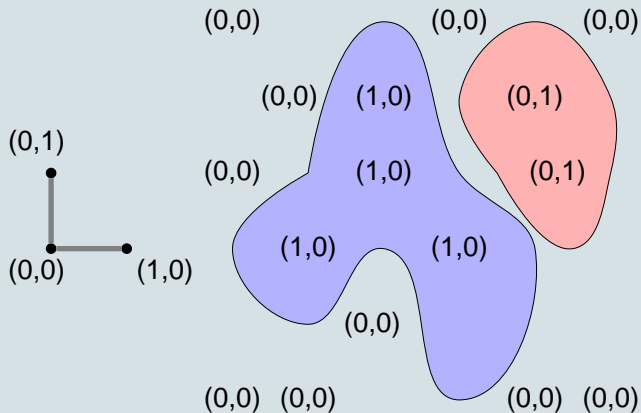


Binary vector maps



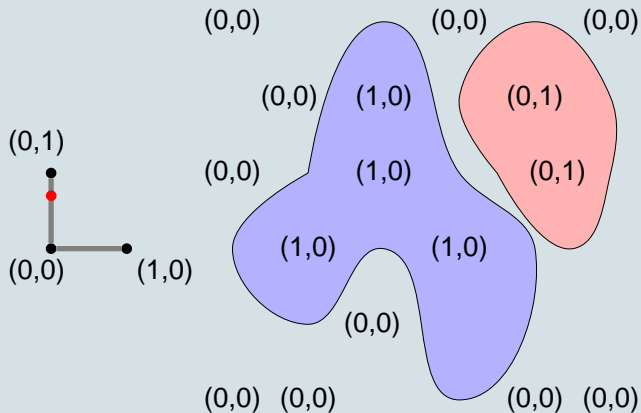
[Tsai et al. MedIA, TMI 2003]

Binary vector maps



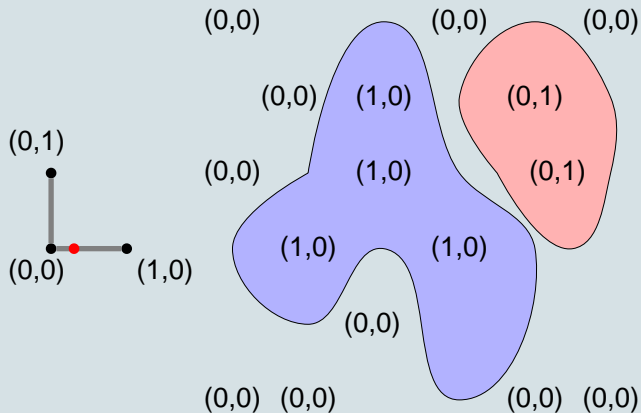
[Tsai et al. MedIA, TMI 2003]

Binary vector maps



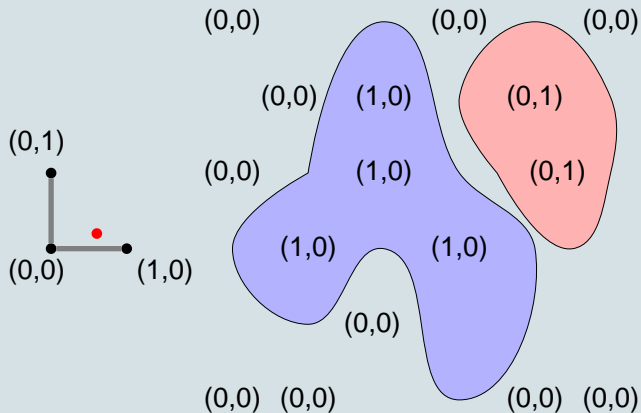
[Tsai et al. MedIA, TMI 2003]

Binary vector maps



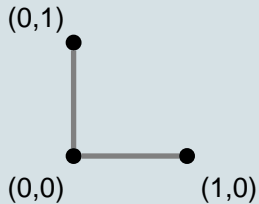
[Tsai et al. MedIA, TMI 2003]

Binary vector maps

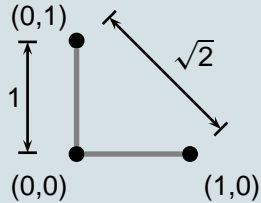


[Tsai et al. MedIA, TMI 2003]

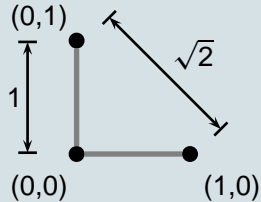
Binary vector bias



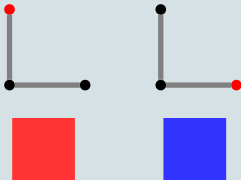
Binary vector bias



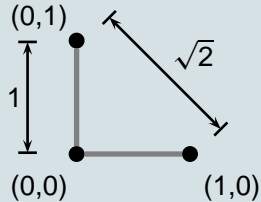
Binary vector bias



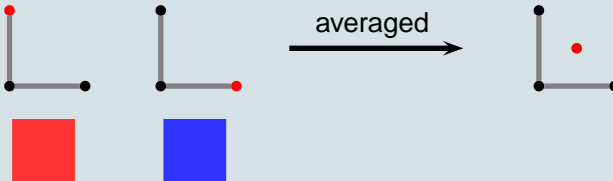
Smoothing: two labels, background



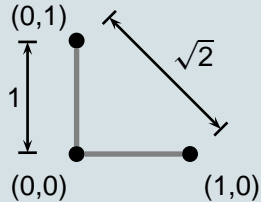
Binary vector bias



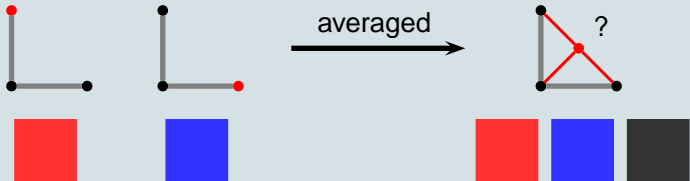
Smoothing: two labels, background



Binary vector bias

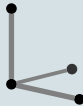


Smoothing: two labels, background



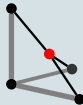
Binary vector bias

Smoothing: three labels, background



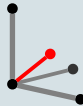
Binary vector bias

Smoothing: three labels, background



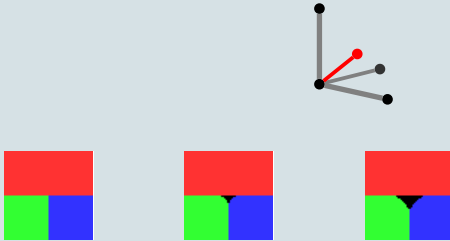
Binary vector bias

Smoothing: three labels, background



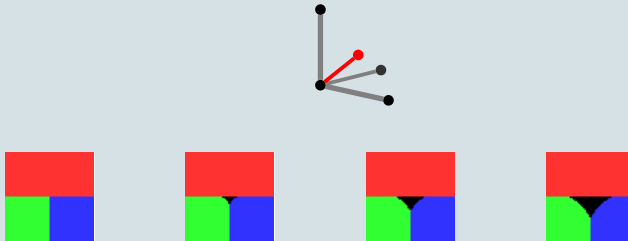
Binary vector bias

Smoothing: three labels, background



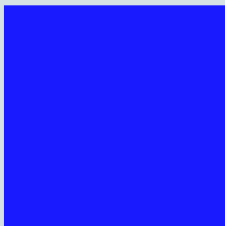
Binary vector bias

Smoothing: three labels, background

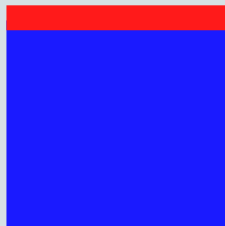


Binary vector bias

Misalignment during registration: $E = \|A - B\|^2$



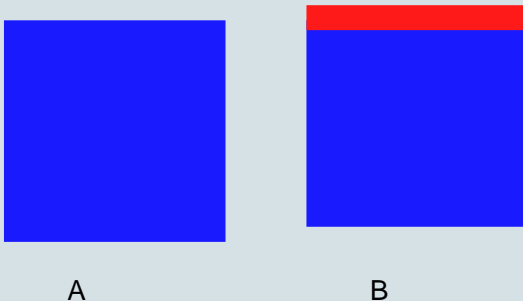
A



B

Binary vector bias

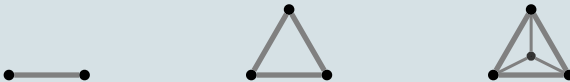
Misalignment during registration: $E = \|A - B\|^2$



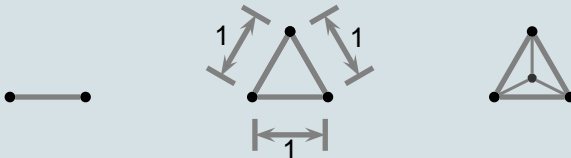
Recap

- ▶ SDMs: interpolation error, excessive variation
- ▶ Binary vectors: bias affected smoothing, registration

Label Space



Label Space



Smoothing

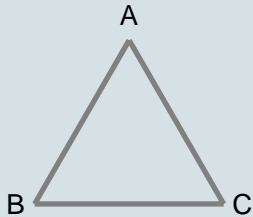
Binary vectors



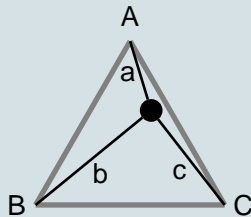
Label space



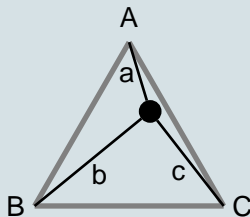
Probabilistically speaking...



Probabilistically speaking...



Probabilistically speaking...



$$P(A) = e^{-a}/Z$$

$$P(B) = e^{-b}/Z$$

$$P(C) = e^{-c}/Z$$

$$Z = e^{-a} + e^{-b} + e^{-c}$$

Probabilities

Binary vectors



Label space



Probabilities

Binary vectors



logit^{-1} [Pohl 2007]

Label space



Probabilities

Binary vectors

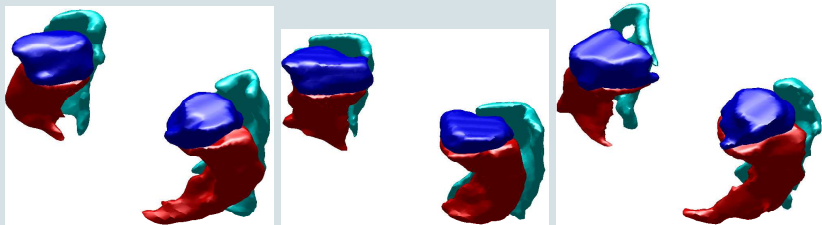


logit^{-1} [Pohl 2007]

Label space



Patient data



Provided by Brigham and Women's Hospital (n = 31)

Registered: $d^2 = \sum \|m_i - \mu\|^2$

Conditional probabilities



Pohl 2007

Principle component analysis

Dice coefficient between image and preimage

Leave-one-out strategy

Principle component analysis

Dice coefficient between image and preimage

Leave-one-out strategy

	SDMs	Binary vectors	Label space
Amy.	0.783 ± 0.0031	0.825 ± 0.0014	0.855 ± 0.0004

Principle component analysis

Dice coefficient between image and preimage

Leave-one-out strategy

	SDMs	Binary vectors	Label space
Amy.	0.783 ± 0.0031	0.825 ± 0.0014	0.855 ± 0.0004
Hipp.	0.782 ± 0.0016	0.819 ± 0.0006	0.843 ± 0.0003

Principle component analysis

Dice coefficient between image and preimage

Leave-one-out strategy

	SDMs	Binary vectors	Label space
Amy.	0.783 ± 0.0031	0.825 ± 0.0014	0.855 ± 0.0004
Hipp.	0.782 ± 0.0016	0.819 ± 0.0006	0.843 ± 0.0003
Para.	0.494 ± 0.0033	0.561 ± 0.0017	0.773 ± 0.0003

Conclusions

Simple, unbiased, flexible

Probabilistic interpretation

Captures uncertainty