Can We Estimate the Motion of the Heart?

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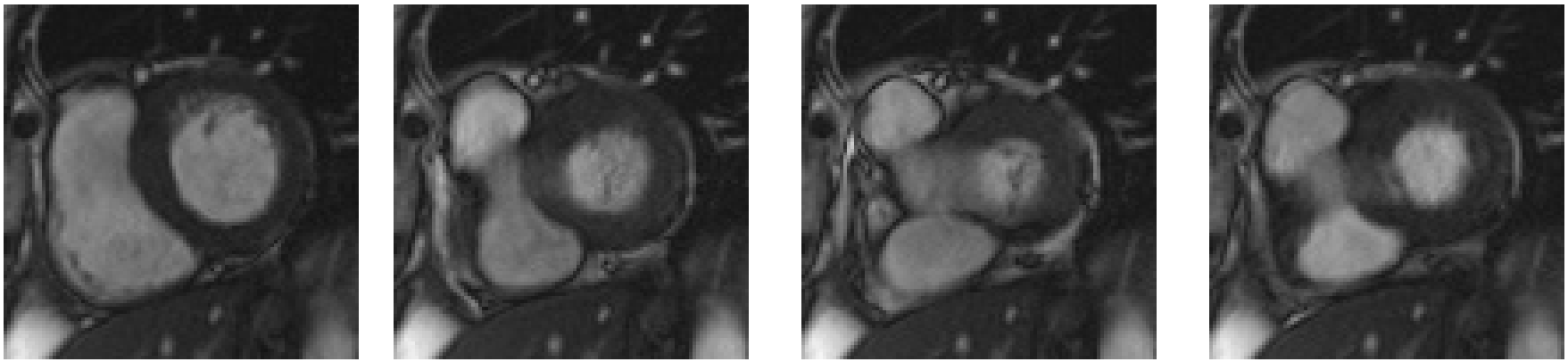
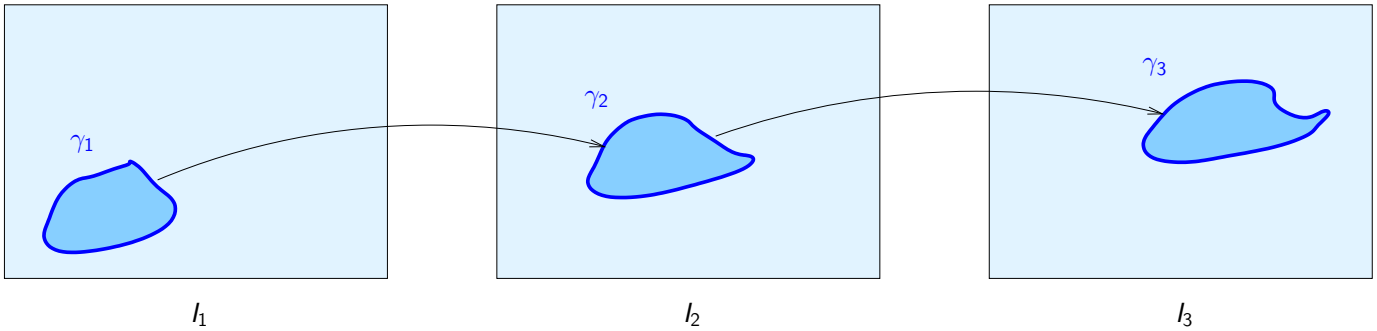
Motivation



From a set of training data we want to estimate a model for the motion of the heart, which can be used to facilitate tasks such as heart segmentation.

Background - in the context of my work

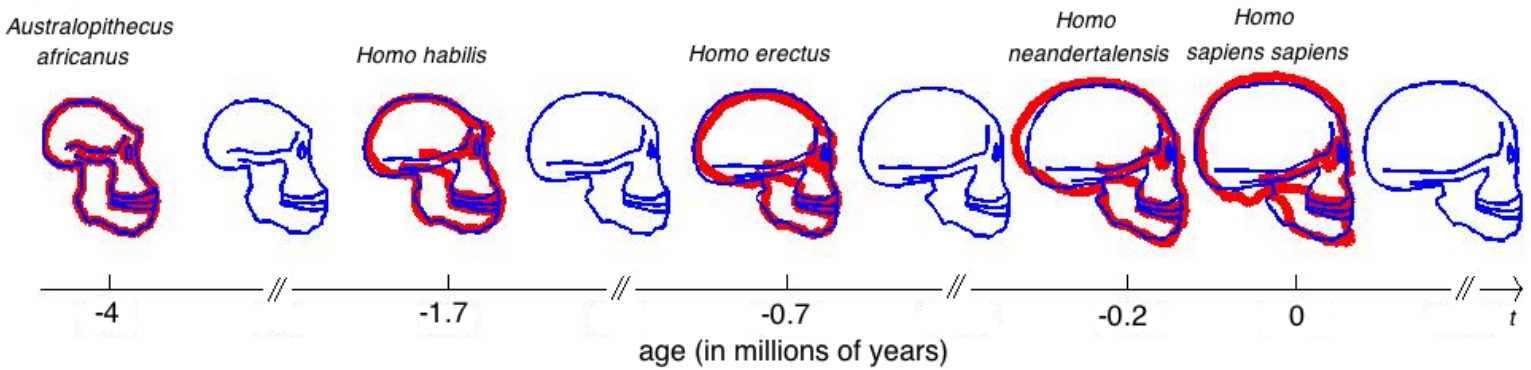


Filtering of shapes:

- define a stochastic model for shape deformation
- use this model to estimate the shape in each image frame

Need shape-specific models.

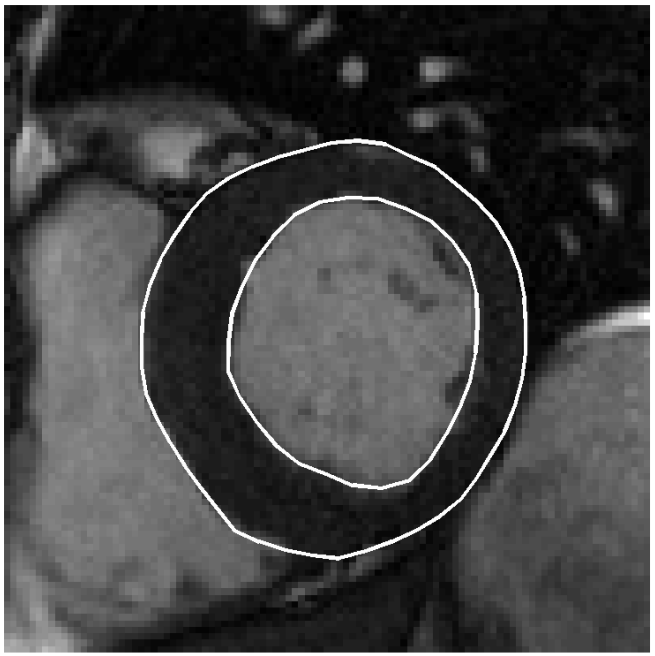
Background - in the context of others' work



- shape and image regression: Stanley Durrleman, Aastha Jain, Francois-Xavier Vialard, Marc Niethammer
- spatiotemporal registration: Stanley Durrleman
- other work?

Data Set

- sequence of manually segmentated shapes $\gamma_1, ..., \gamma_t$



Registration

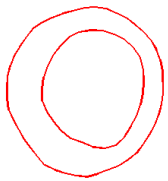
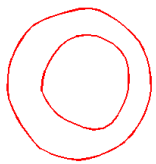
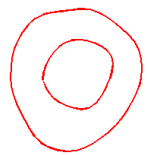
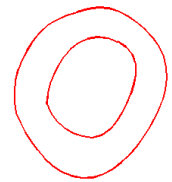
- evolution is along constrained EPDiff:

$$\gamma_{t+1} = \exp^{\sharp}_{\gamma_t}(\alpha_t) \tag{1}$$

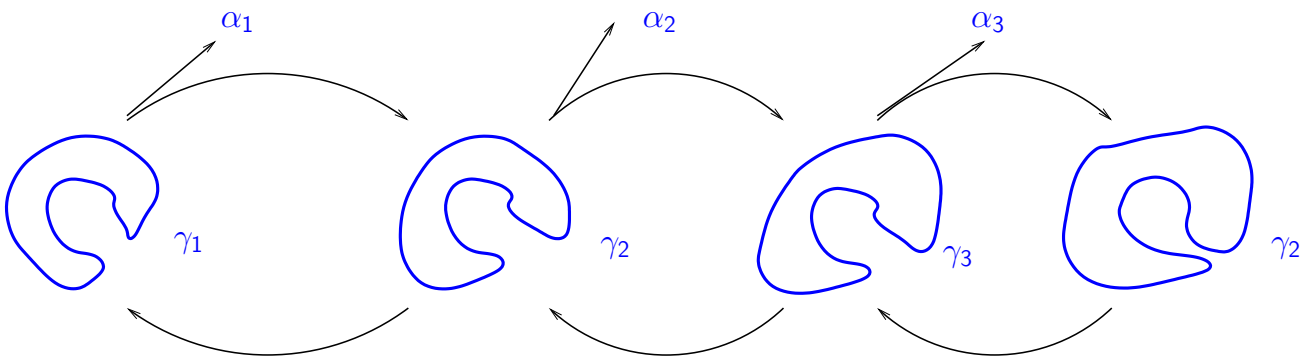
- energy calculates mismatch between the two curves:

$$E(\alpha_t) = \alpha_t^T K_{\gamma_t} \alpha_t + |B_{\gamma_t} - B_{\gamma_{t+1}}| \tag{2}$$

- minimization is with respect to the initial momentum α_t

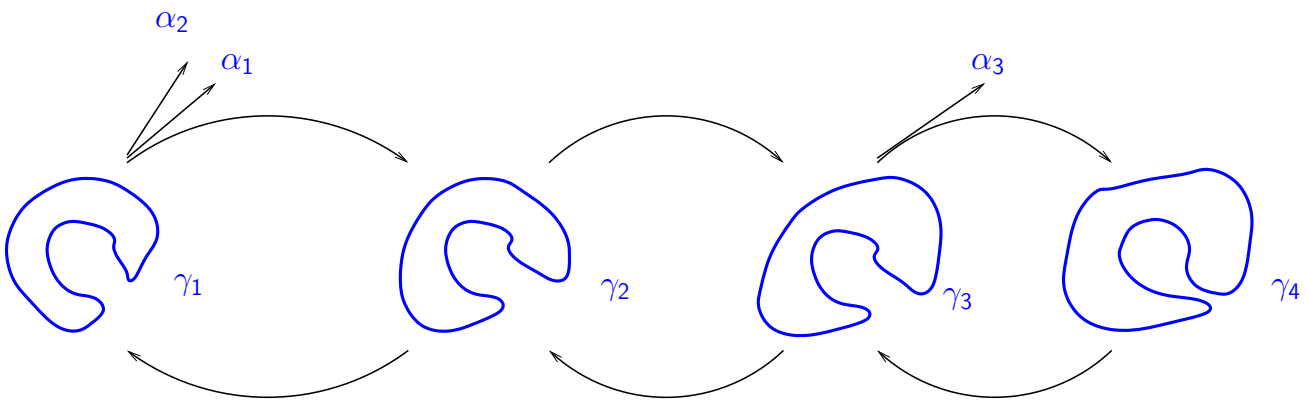





Transport



- using parallel transport - preserving the inner product
- using coadjoint transport - preserving the action of the momentum

Transport



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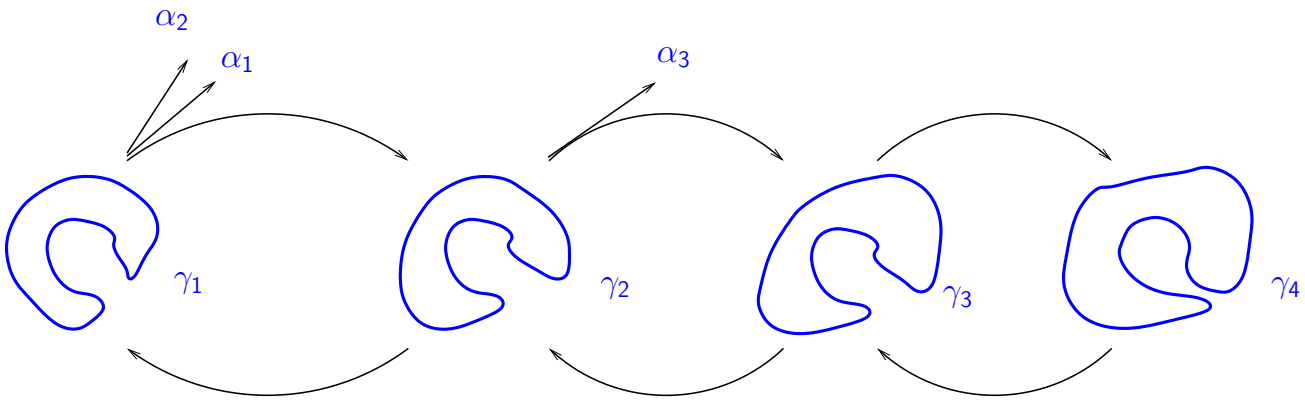

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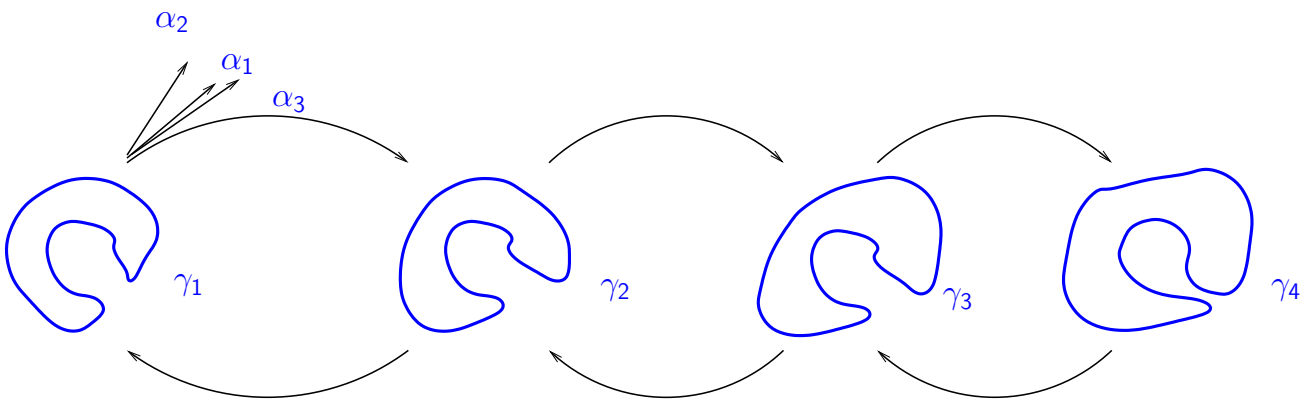

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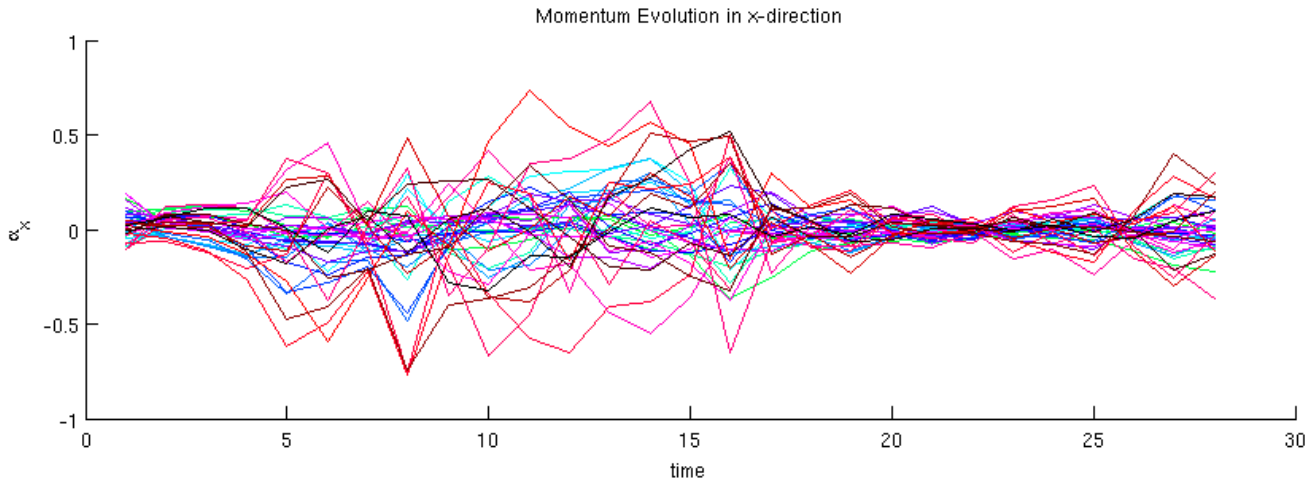
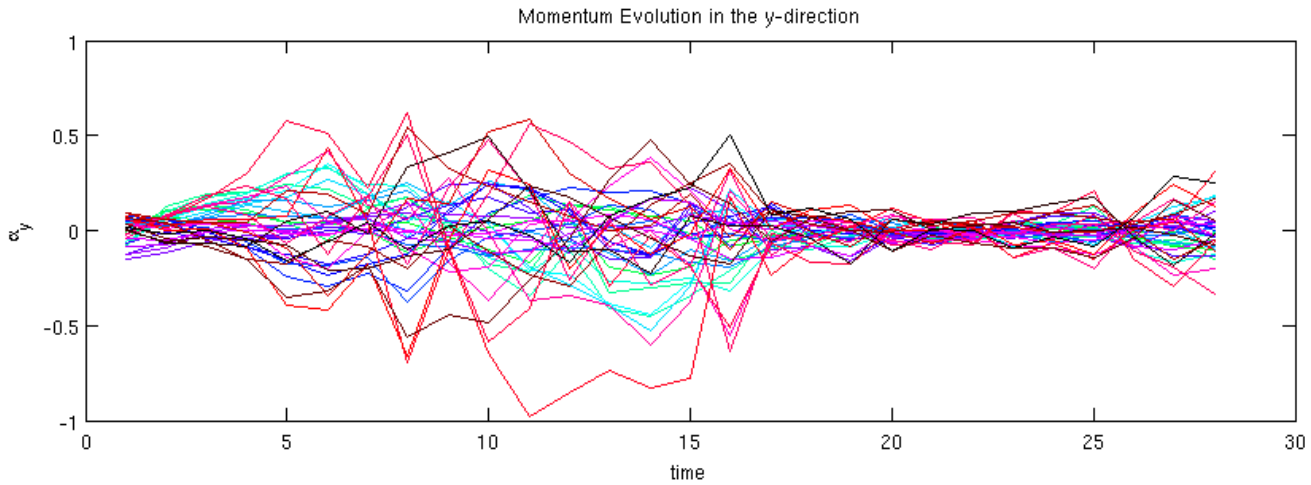
Time series

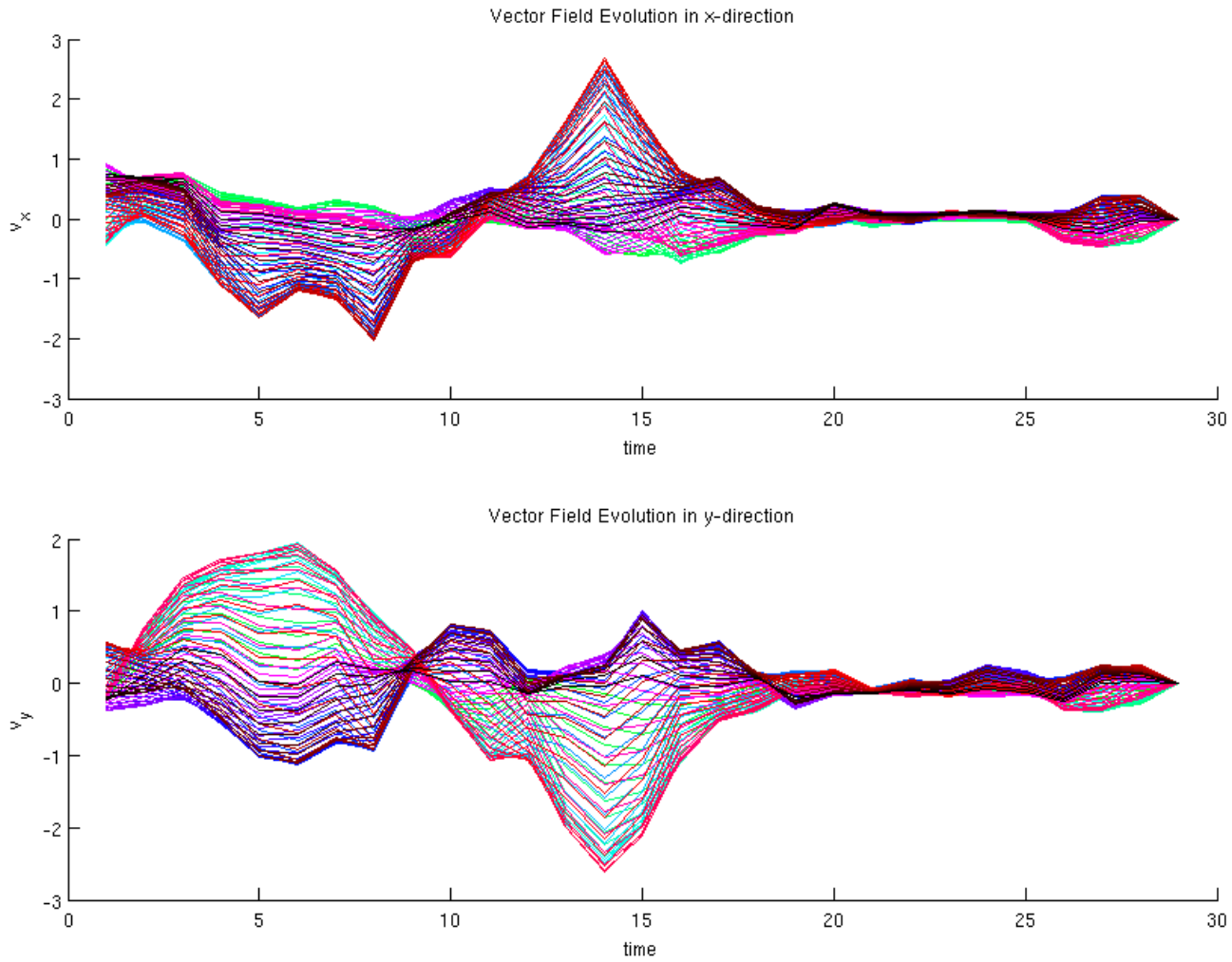
We have obtained a time series of the transported momenta $\tilde{\alpha}_1, ..., \tilde{\alpha}_t$.





Time series

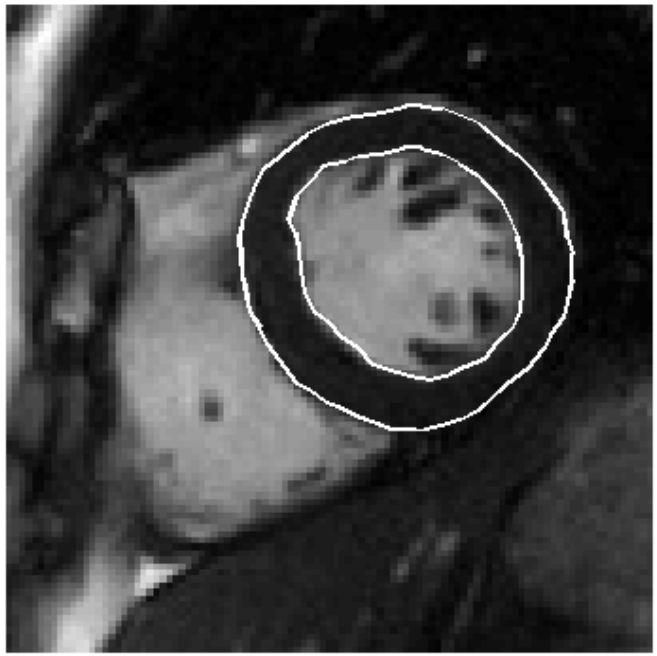
We should rather look at the transported vector fields $\tilde{v}_1, ..., \tilde{v}_t$.



So what?

We can transfer this time series to another shape ρ_1

- find a geodesic between γ_1 and ρ_1
- transport the time series attached to γ_1
- deform ρ_1 based on the dynamics of γ_t



Next steps

- add noise and incorporate in filtering
- fit a model to the time series of vector fields
- use tools from functional data analysis
- compare/classify time series