Recent Advances in the Analysis of 3D Shapes

Preparation Meeting

Daniel Cremers
Emanuele Rodolà
Matthias Vestner
Thomas Windheuser

What You Will Learn in the Seminar

- Get an overview on current trends in 3D shape analysis
- Read and understand scientific publications
- Write a scientific report
- Prepare and give a talk

Important Dates

- First meeting: 28.01.2014 (today)
- Fix assignment of papers and date
- Weekly presentation starting on Wednesday 16.04.2014
- Read and discuss your assigned topic with your supervisor early
- Deliver and discuss your slides and the report **one week before your presentation**

Preparation

Please do not work on your topic completely alone

- Meet at least **twice** with your supervisor
- We recommend to meet your supervisor and discuss your topic **one month before your talk**
- **One week before your talk**: Deliver the report and slides to your supervisor. Meet your supervisor and discuss your slides.

Report

- Report should contain an overview and the main contributions of your assignment
- Recommended length: 6-8 pages
- Required length: Minimum 6 pages
Maximum 10 pages
- Language: English or German (or Italian)
- Write your Report with Latex
Template available on the web page
- Send PDF via email to your supervisor

Presentation

- 40 minutes + 10 minutes for discussion
- Don't put too much information on one slide
  1-2 minutes per slide, about 30-40 slides
- Language: English
- Recommended structure
  1. Introduction, problem motivation, outline
  2. Approach
  [3. Experimental Results]
  4. Discussion
  5. Summary (of scientific contributions)

Presentation

- You are free to choose your presentation software (Powerpoint, OOImpress, ...)
- For discussion with your supervisor you need to export into PDF

Evaluation Criteria

- Gained expertise in the topic
- Quality of your talk
- Quality of the report
- Active participation in the seminar is required (ask questions, comment talks)

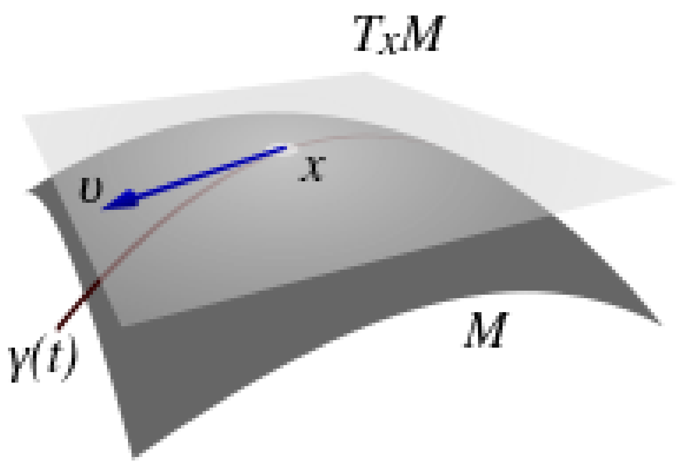
Regular Attendance Is Required

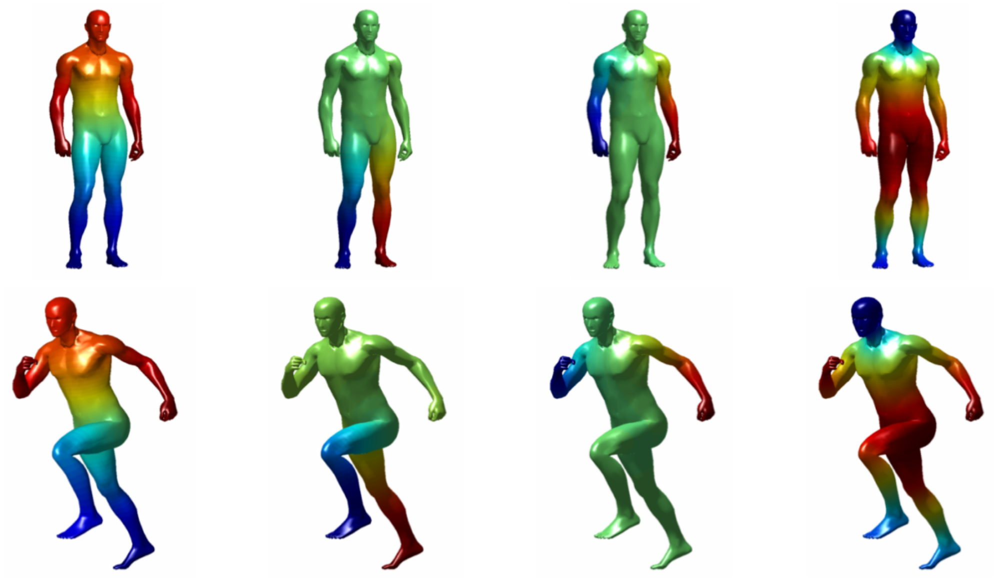
- Attendance at each appointment is necessary
- In case of absence: Medical attest

Overview of Available Topics

Laplace Beltrami Operator
[Textbooks]

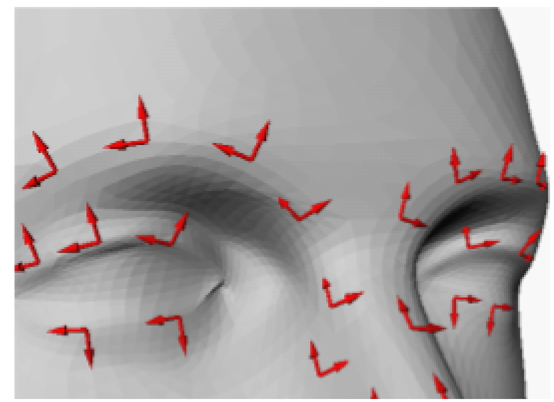
- Signal processing on manifolds
- Invariance to isometric deformations
- Presentation Apr. 16th

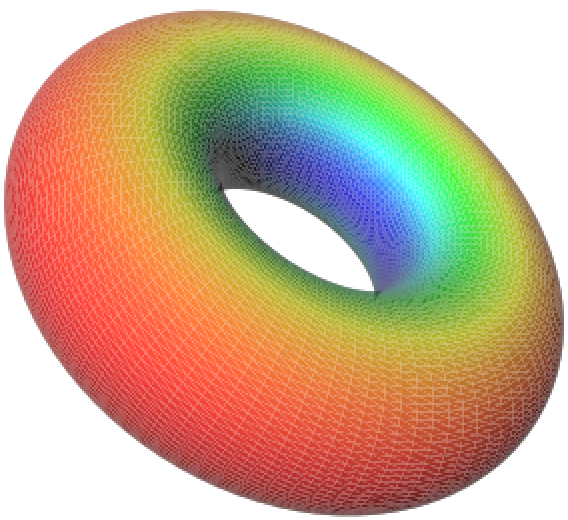


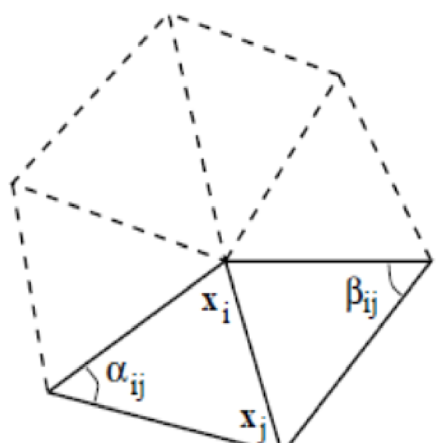


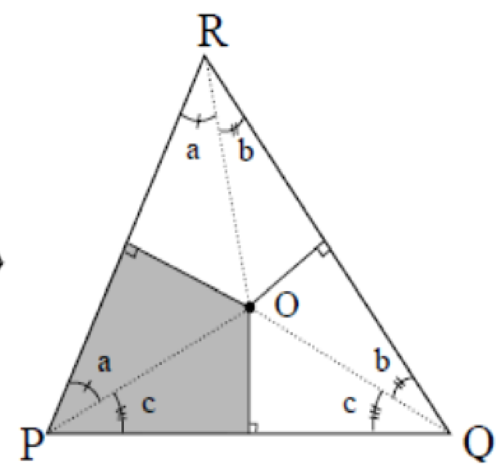
Discrete Differential-Geometry
[Meyer, Desbrun, Schröder, Barr]

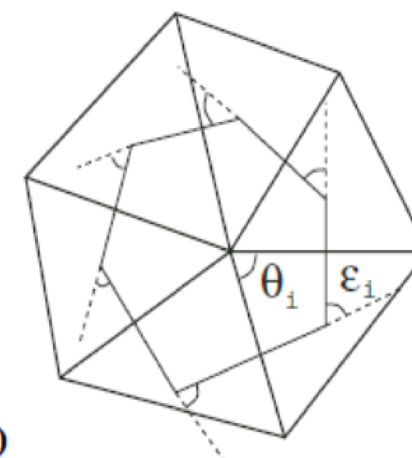
- Approximating normal vectors and curvatures on triangular meshes
- Presentation April 23rd





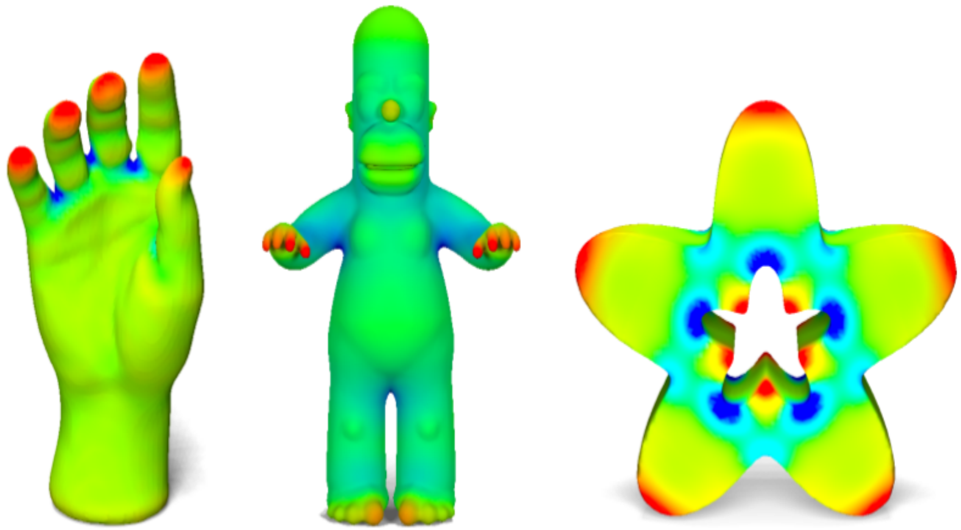


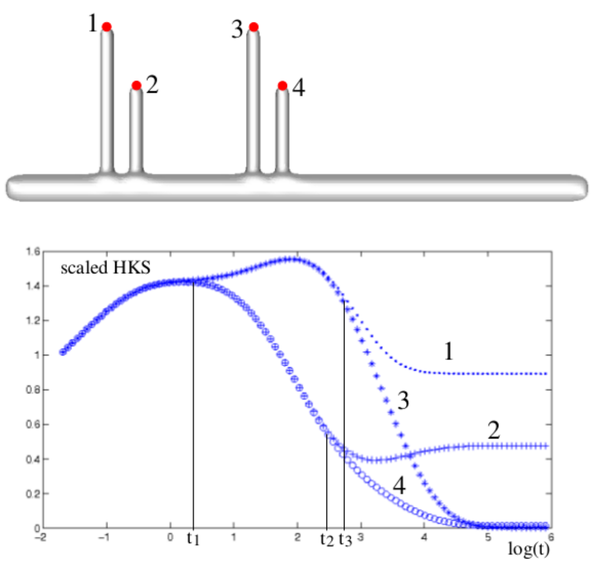




The Heat Kernel Signature

[Sun, Ovsjanikov, Guibas]

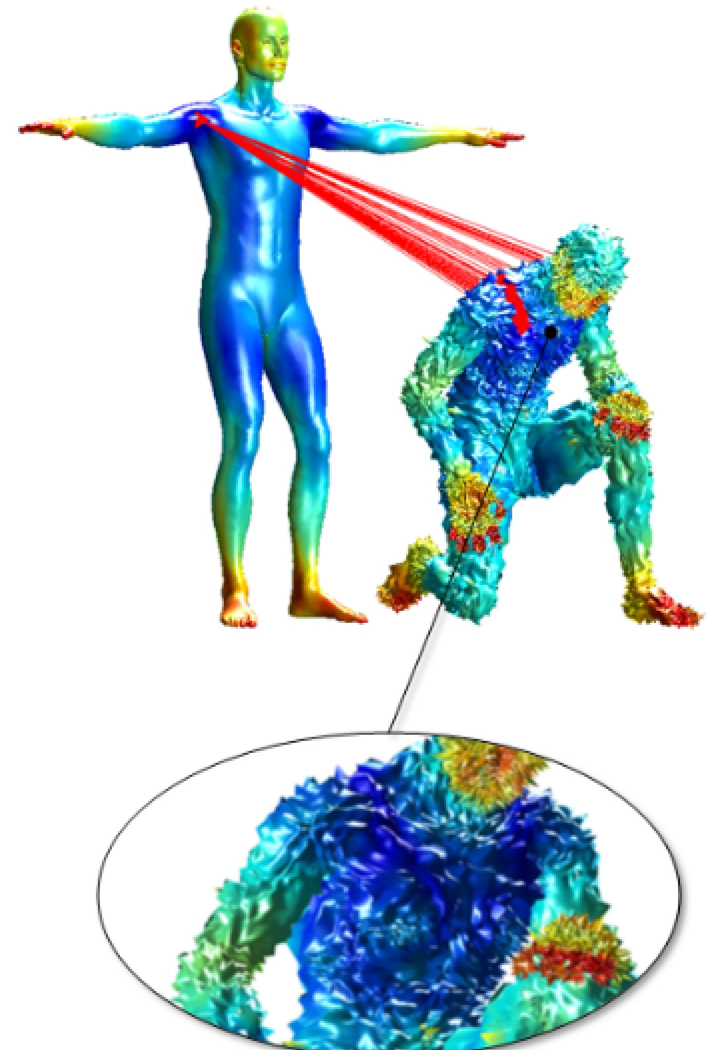


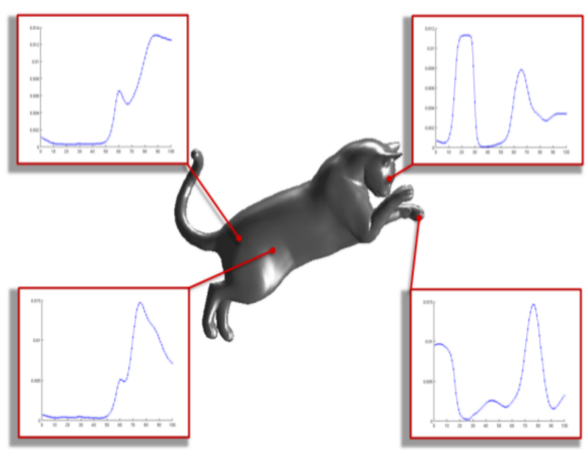


- Multi-scale feature descriptor
- Describes the diffusion of heat
- Presentation April 30th

The Wave Kernel Signature
[Aubry, Schlickewei, Cremers]

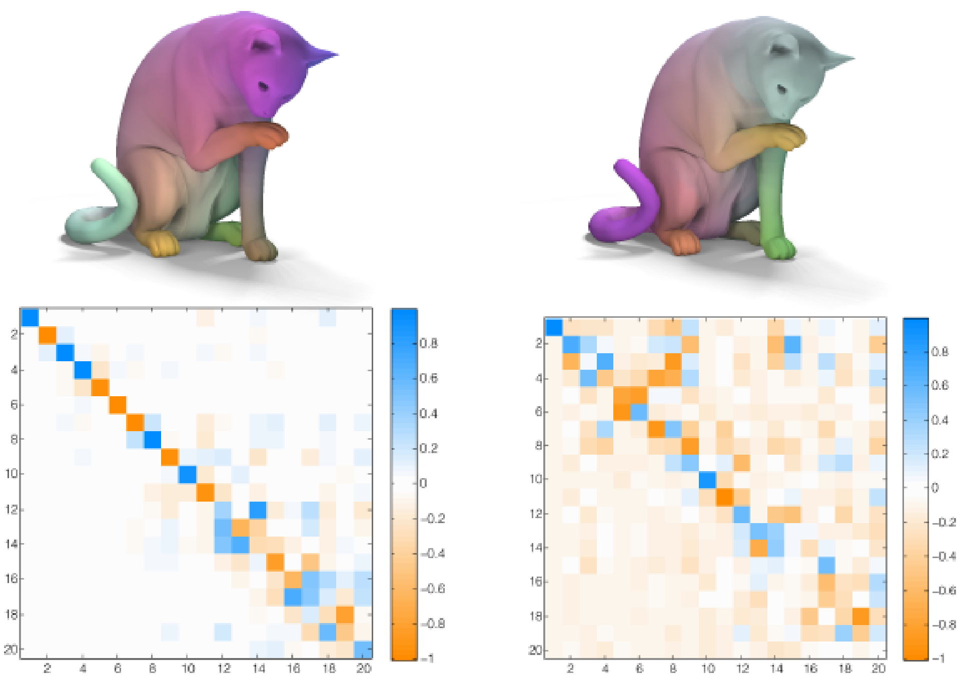
- Multi-scale feature descriptor
- Describes behavior of quantum particles
- Presentation on May 7th





Functional Maps
[Ovsjanikov, Ben-Chen, Solomon, Butscher, Guibas]

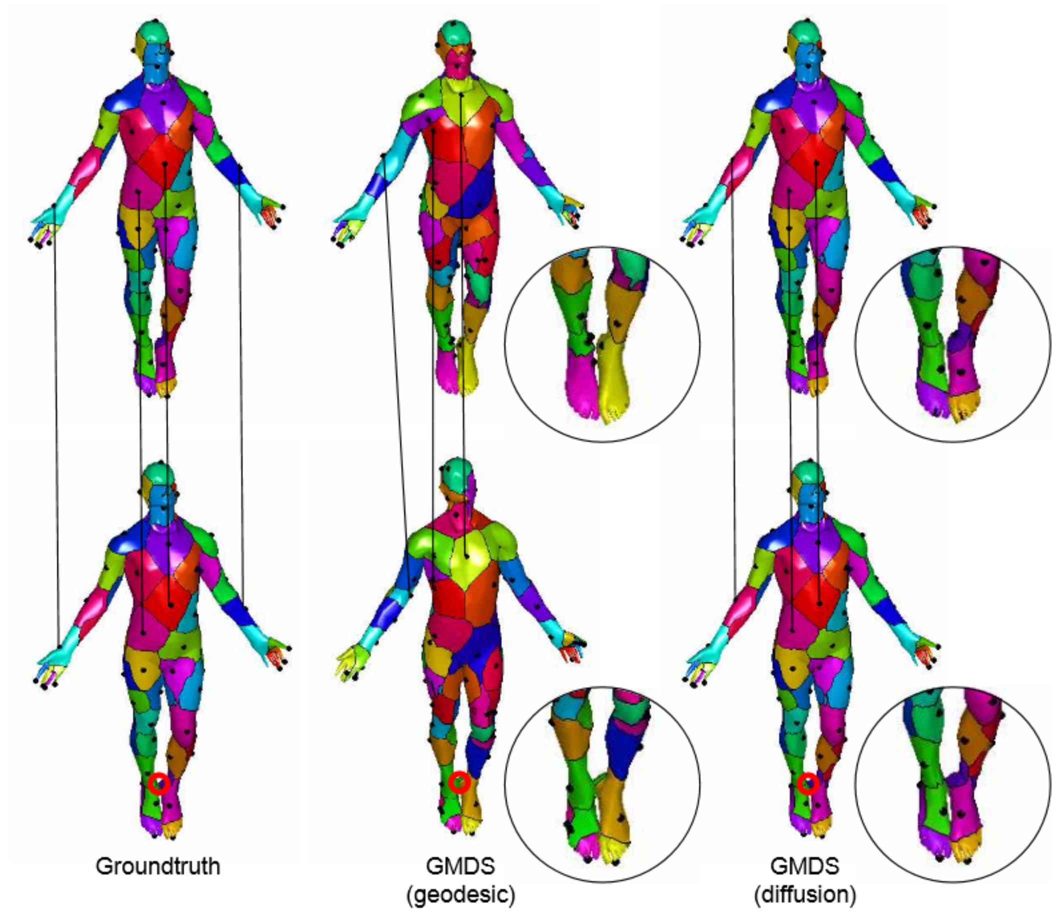
- Instead of points functions are mapped between shapes
- Functions are represented in the Laplace-Beltrami-Operators' Eigenbasis
- Presentation on May 14th



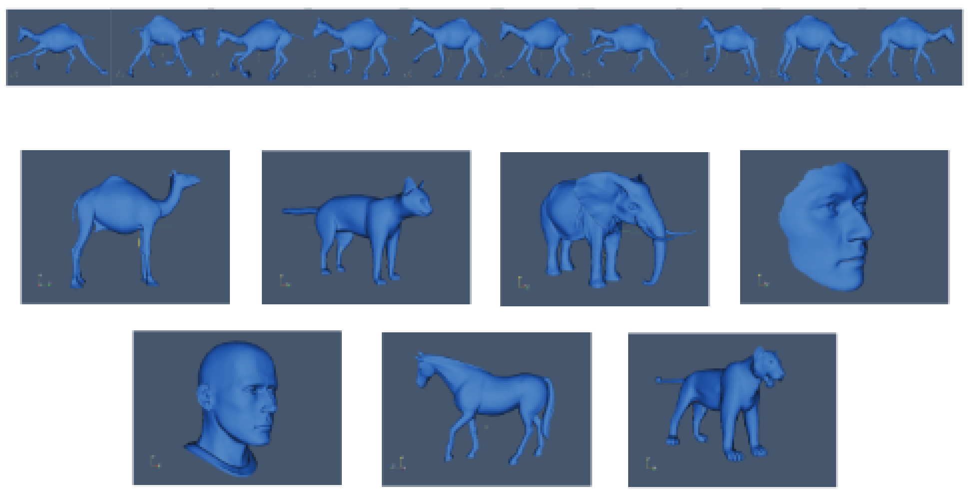
Generalized Multidimensional Scaling
[Bronstein, Bronstein, Kimmel, 2006]

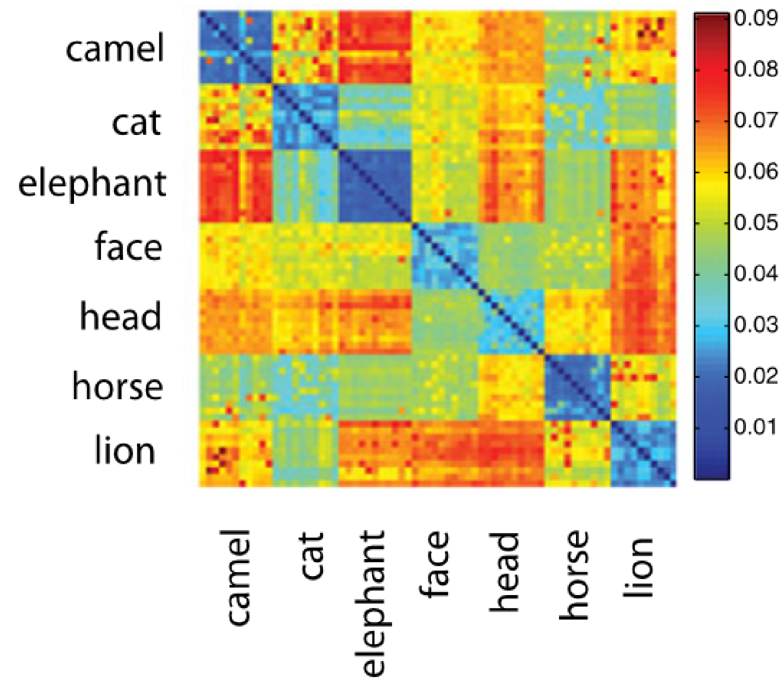
- Shapes are viewed as metric spaces
- We look for the least metric distortion embedding one surface into the other

- Presentation on May 21



The Metric Approach to Shape Matching
[Mémoli, 2007]

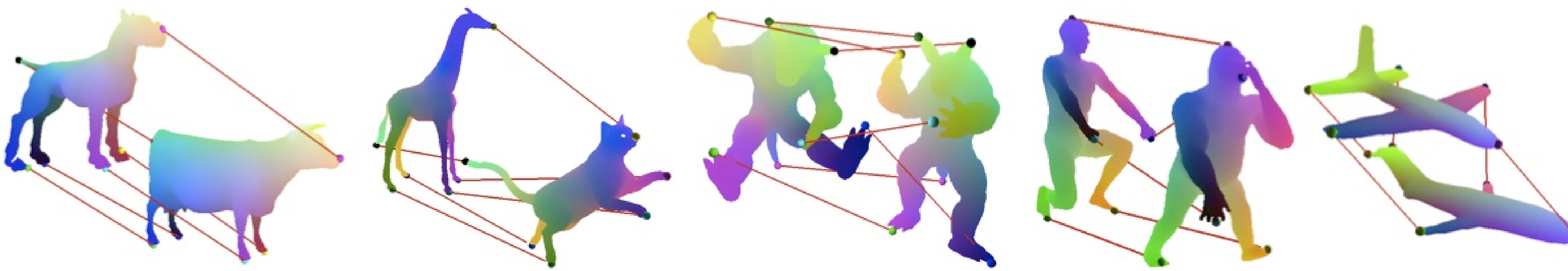




- Objects are viewed as metric-measure spaces
- A notion of *distance* among shapes is defined

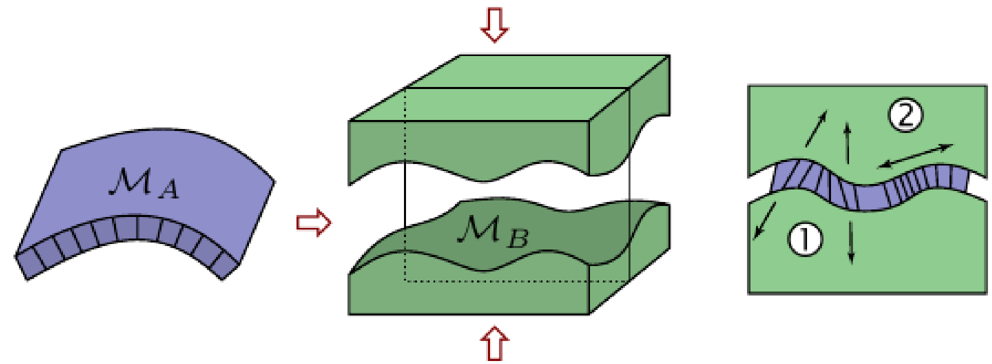
- Presentation on May 28

Blended Intrinsic Maps
[Kim, Lipman, Funkhouser, 2011]

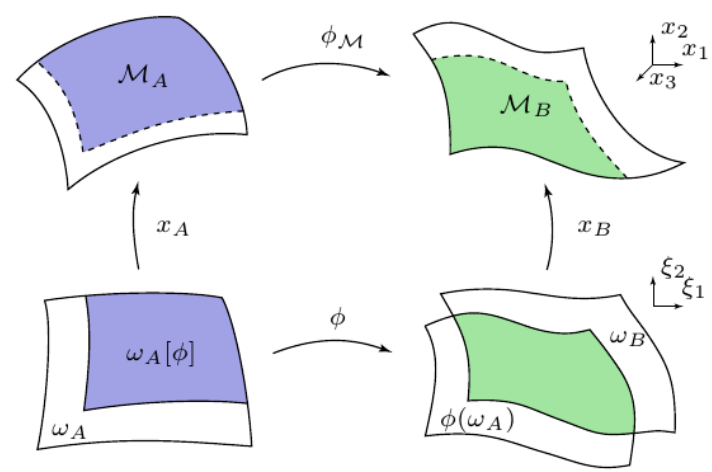


- Given a collection of nearly-isometric maps in input, combine them to produce a better map
- Conformal maps are considered as an input
- The approach allows comparing cats to giraffes
- Presentation on June 4

Diffeomorphic Matching
[Litke, Droske, Rumpf, Schröder, 2005]



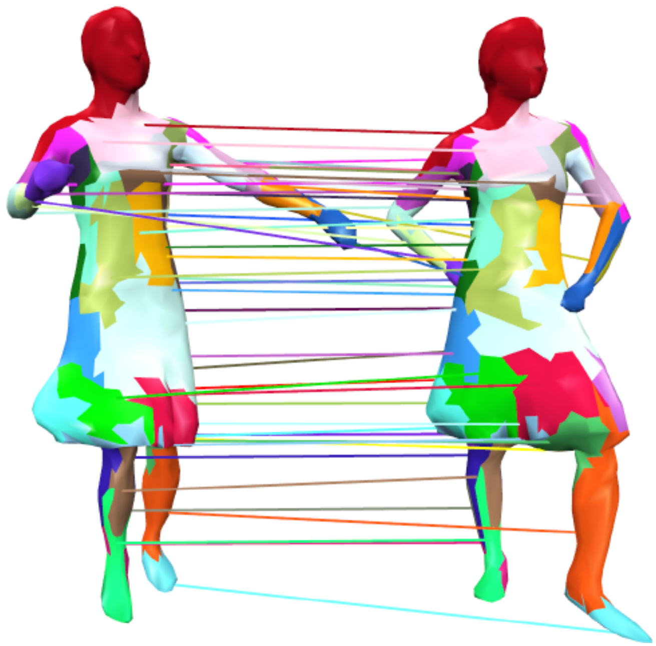
- Match two shapes by a diffeomorphism
- Use image processing methods for optimization
- Presentation on June 11

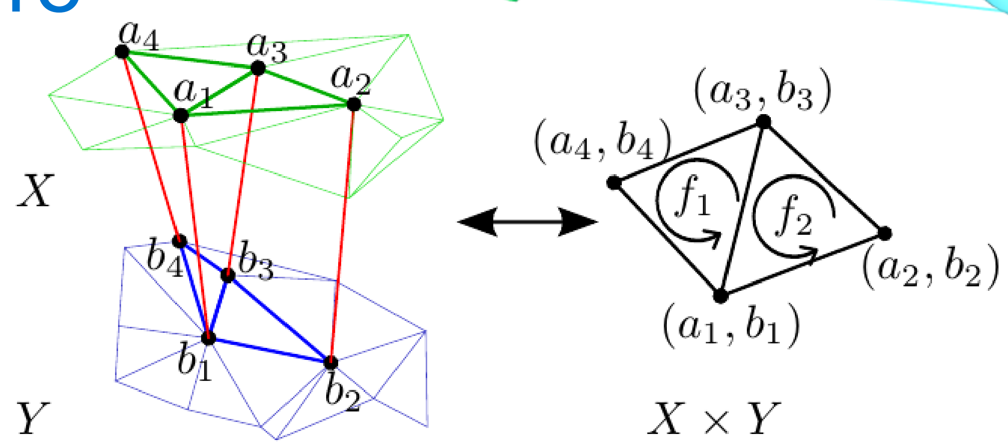


LP Relaxation for Elastic Matching

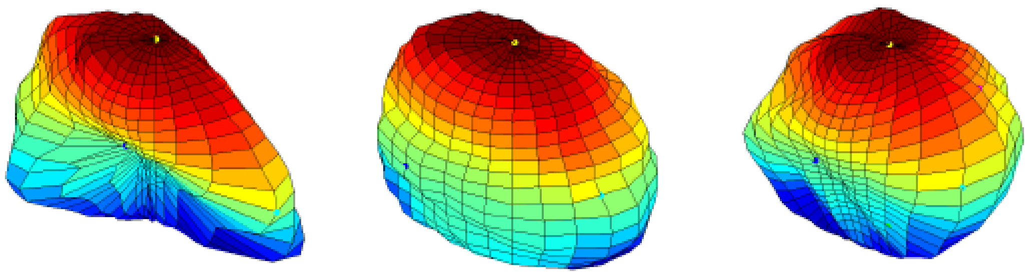
[Windheuser, Schlickewei, Schmidt, Cremers, 2011]

- Match two shapes by a diffeomorphism
- Use linear programming for optimization
- Presentation on June 18

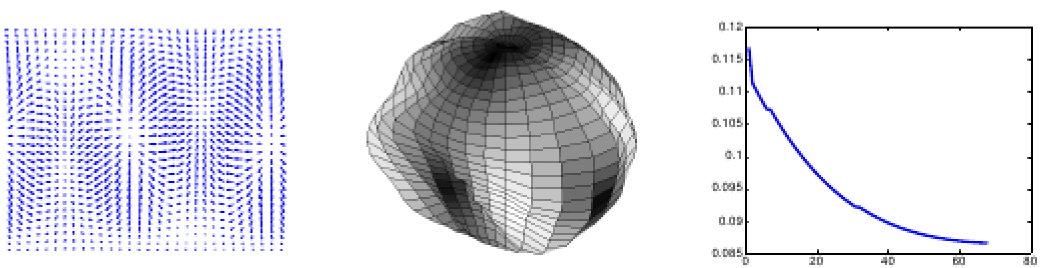




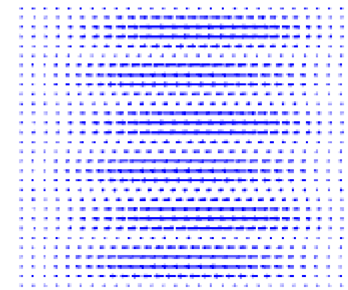
Riemannian Shape Analysis
[Kurtek, Klassen, Ding, Srivastava, 2010]



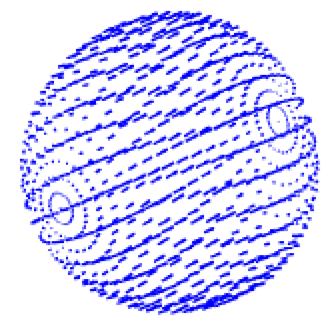
f_1 f_2 $f_2 \circ \gamma^*$



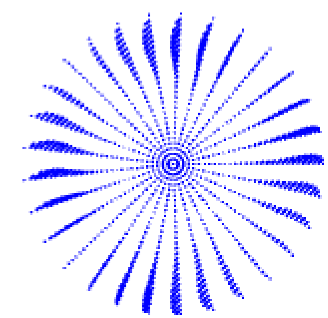
- Represent shapes as “q-maps”
- Gradient based optimization.
- Presentation on June 25



$D = [0,1]^2$

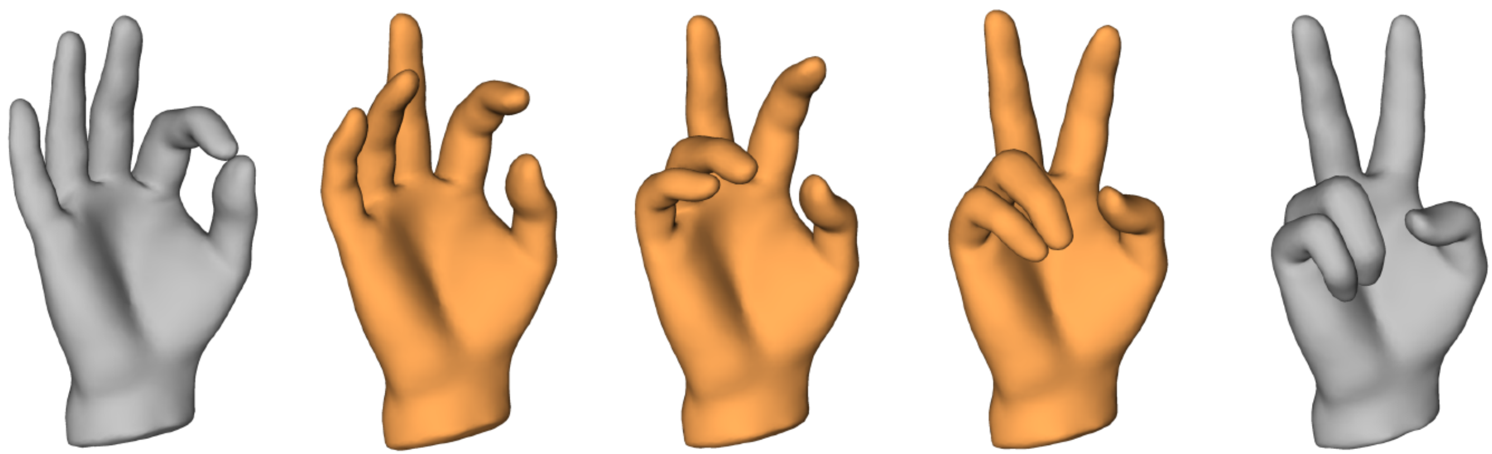


$D = \mathbb{S}^2$

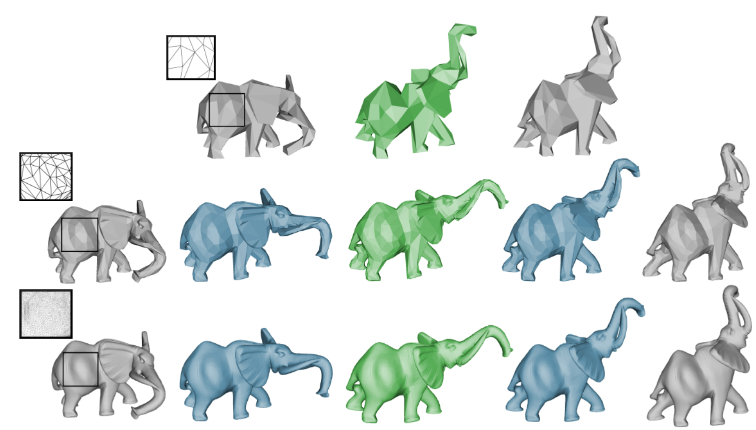


$D =$unit disk

Time-Discrete Geodesics in Shape Space
[Heeren, Rumpf, Wardetzky, Wirth, 2012]



- Physics based deformation model
- Deformation is a path in shape space
- Presentation on July 2



Learning Spectral Descriptors
[Litman, Bronstein, 2012]

- An optimal descriptor can be computed for a given collection of shapes
- The learning approach is based on signal processing
- Presentation on July 09