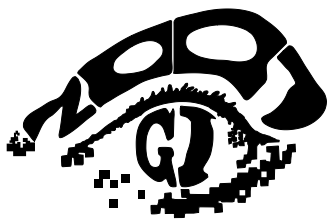
Calligraphic Packing

Jie Xu Craig S. Kaplan



Computer Graphics Lab
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University of Waterloo

GI'07
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Outline

Artistic Packing

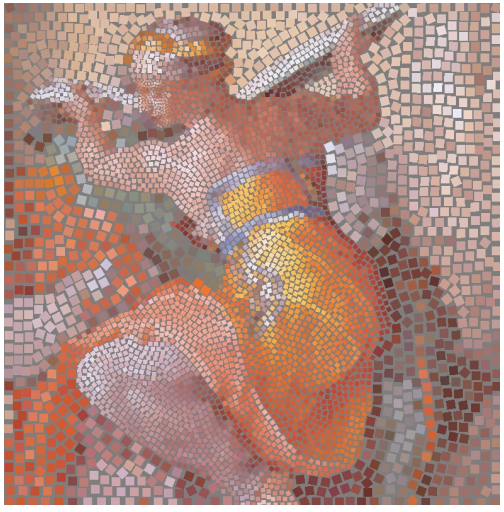
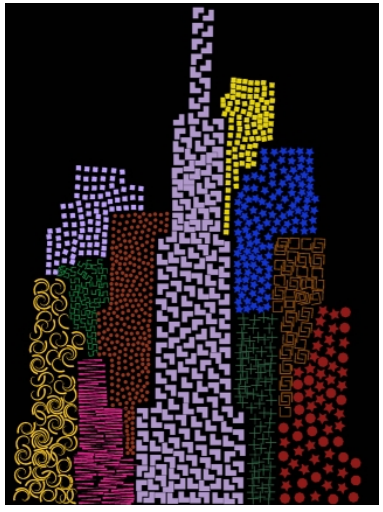
- Representing a large image from smaller, recognizable elements.
- It has been explored by many artists.

Giuseppe Arcimboldo

Sandro Del-Prete

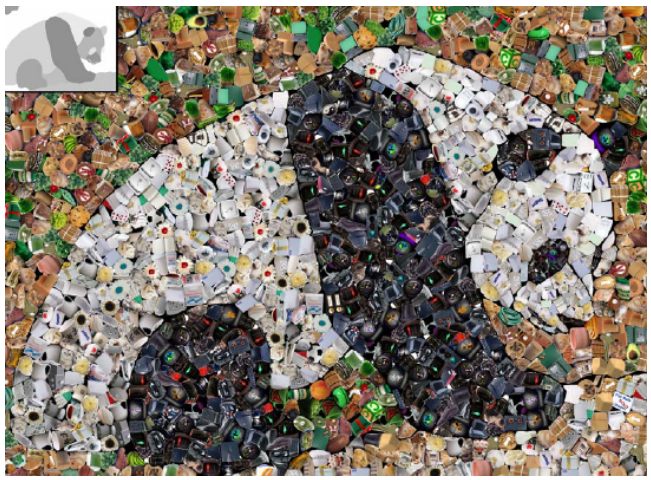
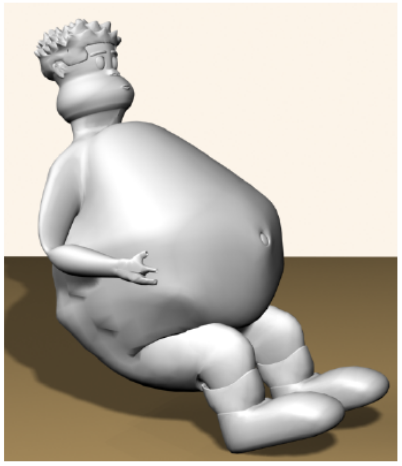
Image Packing

- Hausner, Simulating decorative mosaics, SIGGRAPH 2001.
- Dalal et al., A spectral approach to NPR packing, NPAR 2006.
- Kaplan and Salesin, Escherization, SIGGRAPH 2000.


NPR packing

- Kim and Pellacini, Jigsaw image mosaics, SIGGRAPH 2002.
- Gal et al., Non-realistic expressive modeling, SIGGRAPH 2006 sketch.

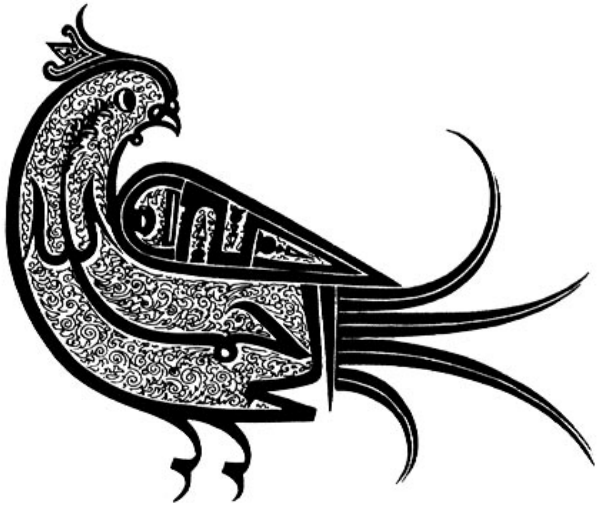

Transfer to Text

- Use text to tile a shape.
- Letters should be legible.
- **Letters can stand a significant amount of deformation.**

Transfer to Text

- Jigsaw image mosaics: only support minor deformation.
- Decorative mosaics and spectral packing: aim at packing a large number of small elements without deformation.
- Escherization: tile a plane with a lot of copies of one deformed shape strictly.
- Expressive modeling: compose 3D shapes with rigid motion.

Islamic Calligraphy



by Hassan Musa

Representational Calligraphy

by AlmapBBDO

Representational Calligraphy

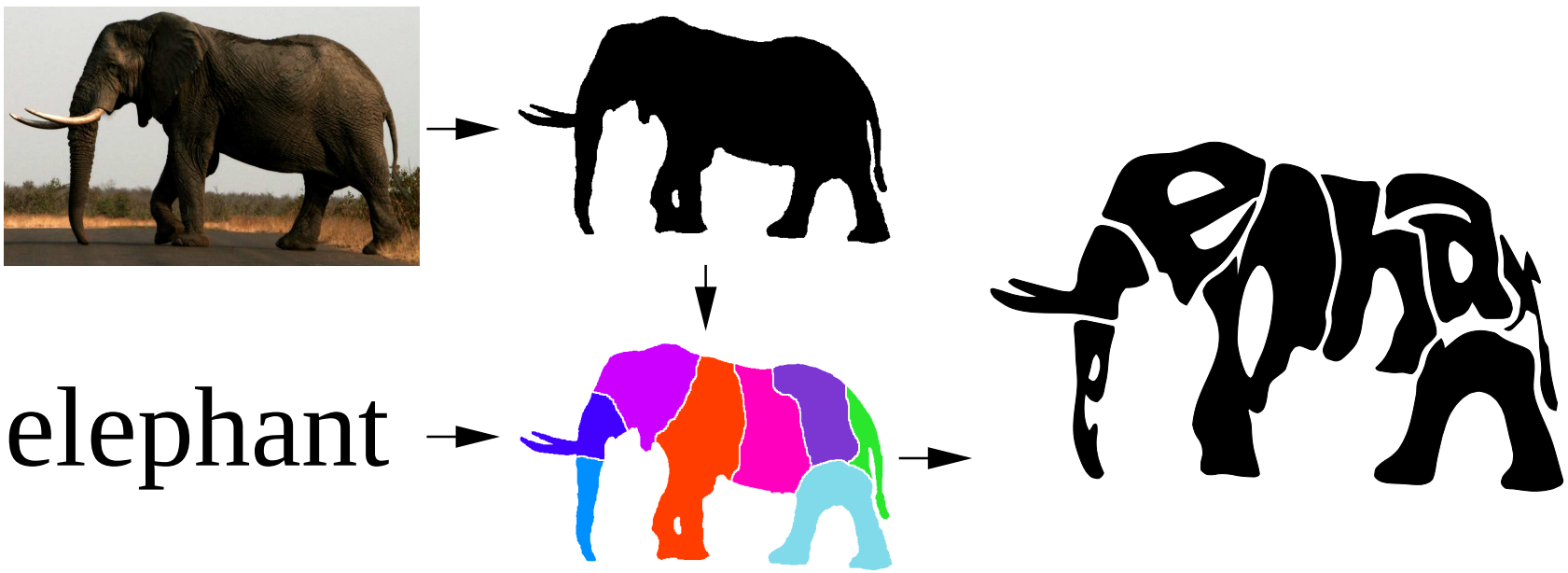
Calligraphic Packing

It is a combination of calligraphy and packing. Given a region and a sequence of letters, construct a non-overlapping arrangement of deformed glyphs.

- The glyphs fill the region as much as possible.
- Glyphs are recognizable.
- The arrangement should follow the order of these letters.

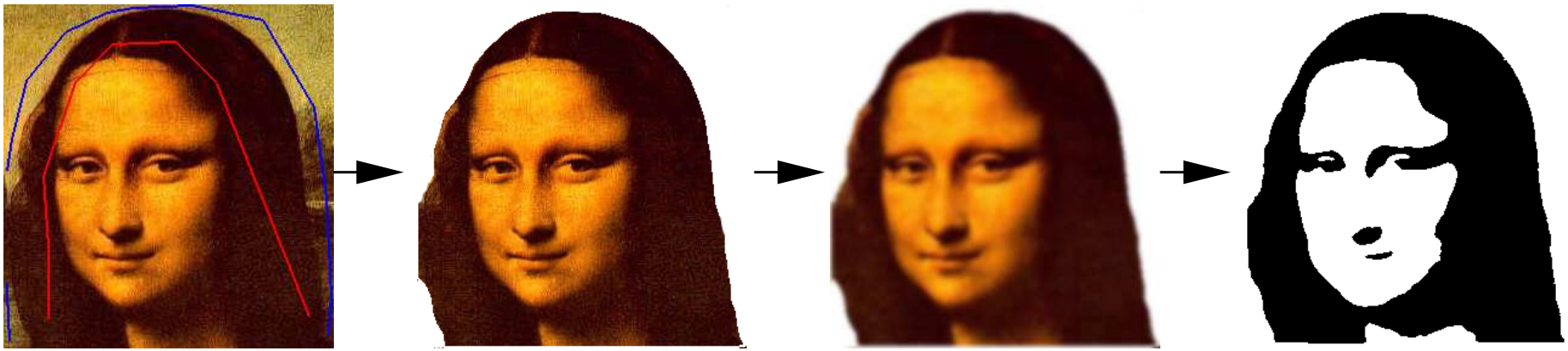
Algorithm

- Convert an image into a container.
- Subdivide image into regions.
- Warp the letters into these regions.



Container Extraction

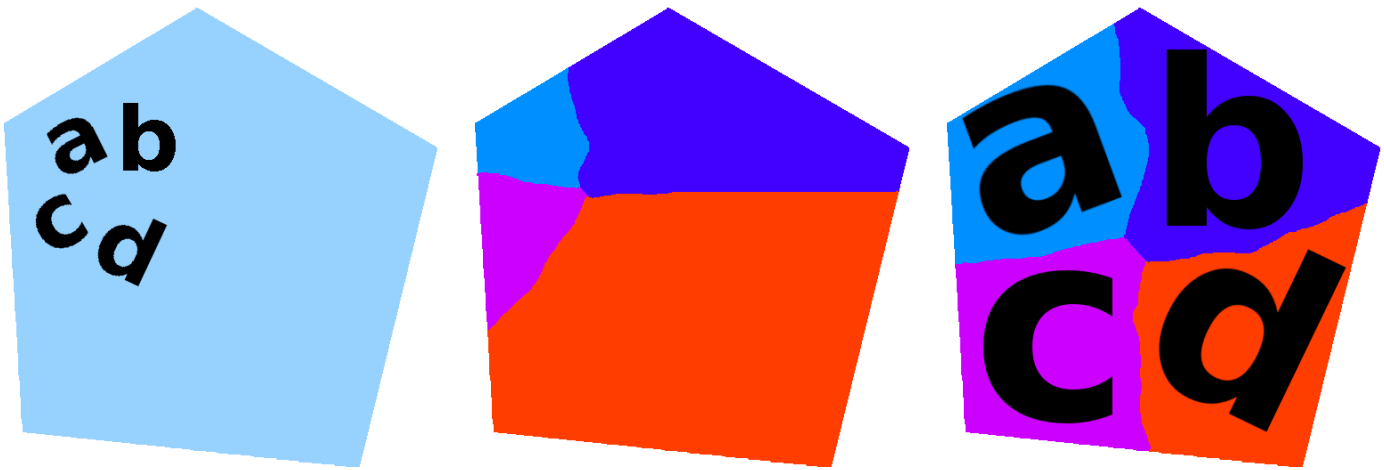
- Use graph-cut algorithm to remove background.
- Apply Gaussian blur to smooth the image.
- Threshold the image to produce a bi-level result.



(a) (b) (c) (d)

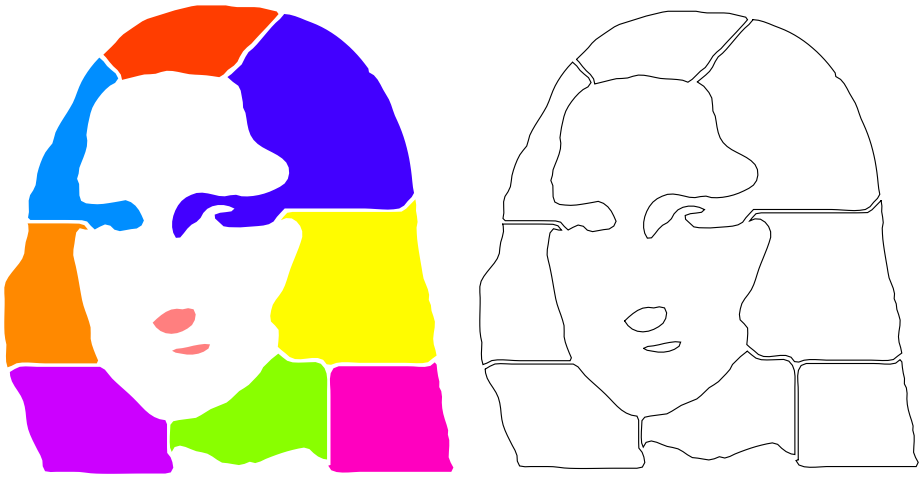
Subdivision

- Set the starting arrangement of letters.
- Run a level-set algorithm to grow letters and cluster pixels.
- Use Lloyd's method to create an even arrangement.



Convert Regions into Paths

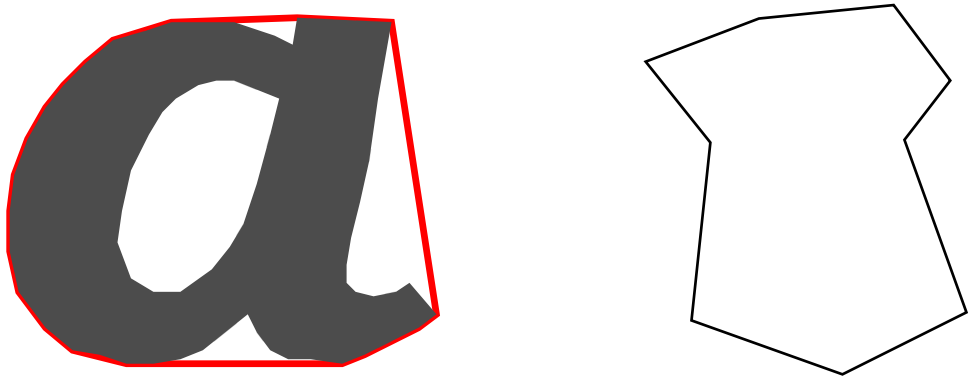
- Smooth the boundaries of regions by morphological operations.
- Trace the boundary to extract paths.



Warping

Create a mapping from the convex hull of glyph to the subregion.

- Given the convex hull C_i of glyph and the subregion R_i.
- Do convex partition for the subregion.
- Place the same number of sample points around C_i and R_i.
- Select a correspondence.
- Create subdivision for the convex hull.
- Do warping in each convex piece.



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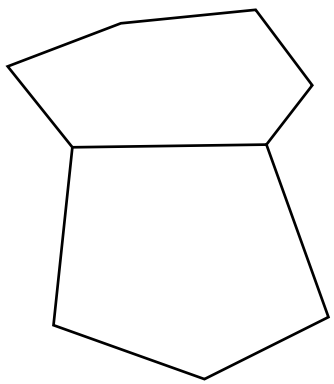

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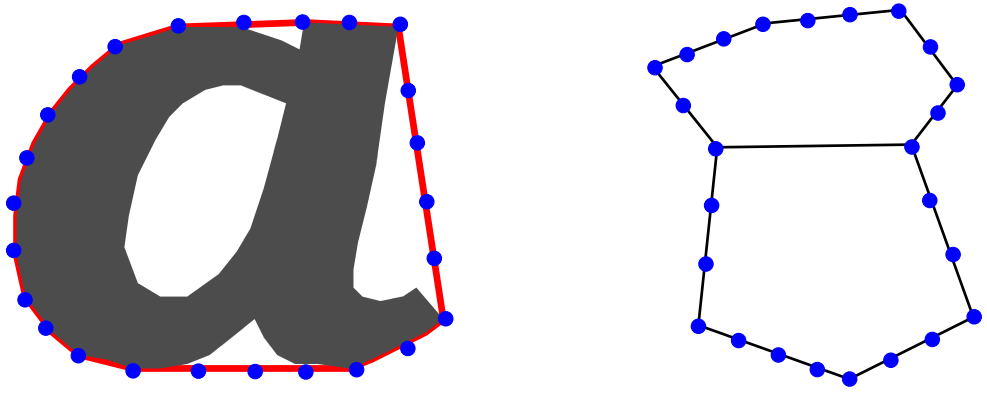

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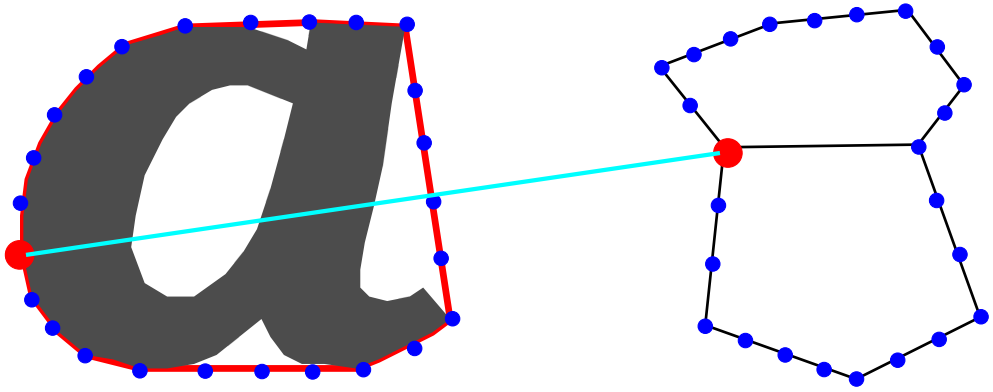

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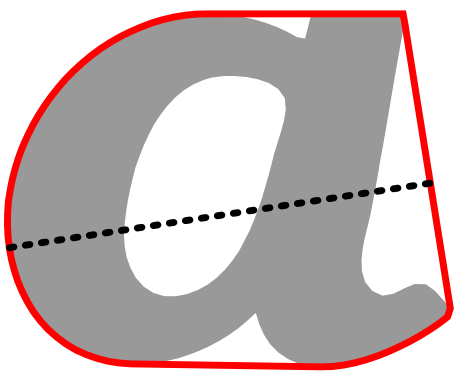

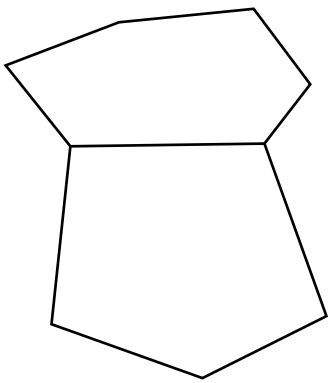

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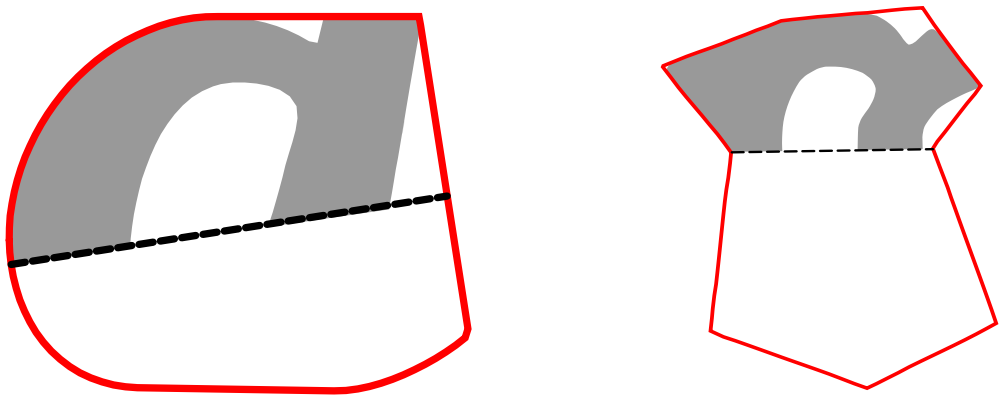

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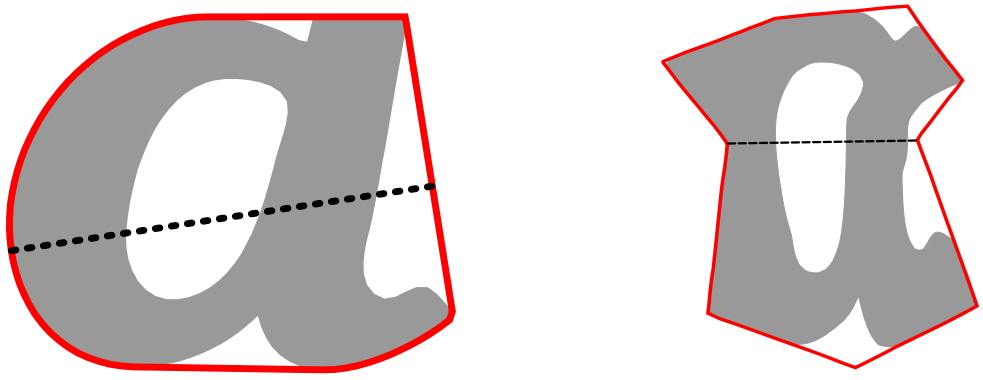
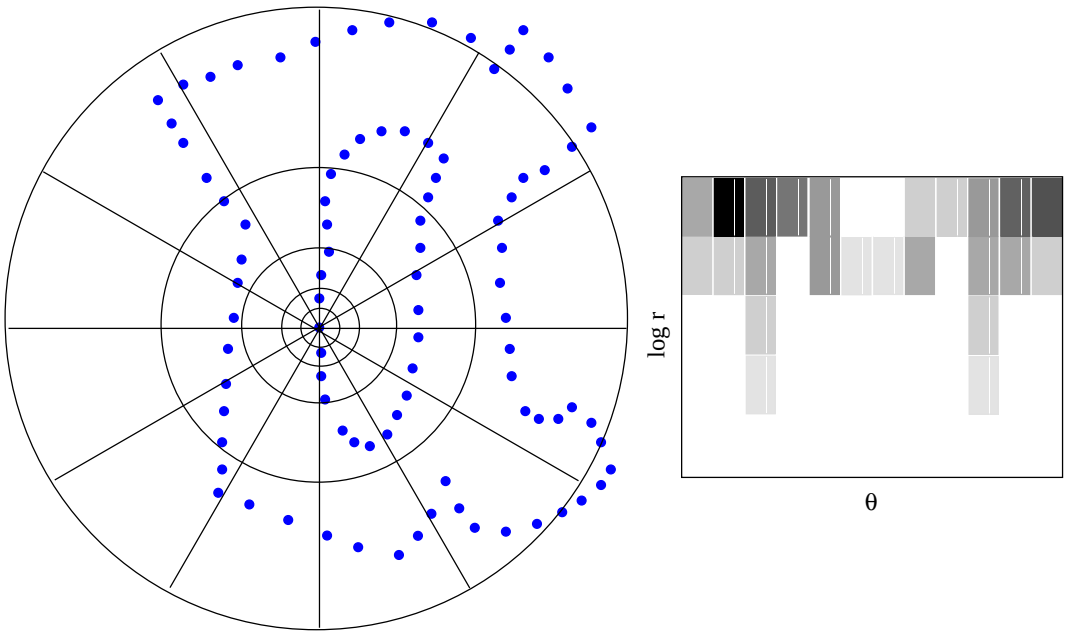


Geometric Shape Cost

- Use "shape context" to measure the similarity of two shapes.
- Compute a log-polar histogram for every reference point.
- Compute the geometric similarity $\triangle_g$ as the sum of histogram distance between all pairs of points.



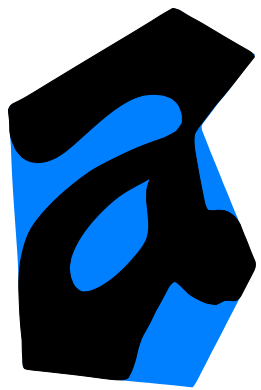
Orientation Cost

- Orientation is important to preserve legibility.

- Use a least-square method to compute the rigid motion from original glyph to warped one.
- From the rotation angle θ, we define the orientation cost: $\triangle_o = \theta/\pi$.

Area Cost

- Warped glyphs should fill the subregions as much as possible.
- Area cost is defined as: $\triangle_a = 1 - A_w/A_r$.



Total Cost

Shape matching cost is $\triangle = \alpha \triangle_g + \beta \triangle_o + \gamma \triangle_a$.

cost=0.328 cost=0.369 cost=0.371 cost=0.429 cost=0.512

Warping Multiple Typefaces

For each letter, we warp lowercase and uppercase glyphs from multiple typefaces.

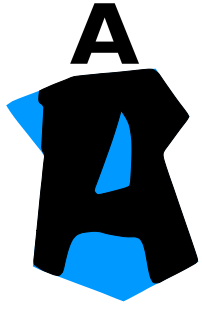
cost=0.324

cost=0.396

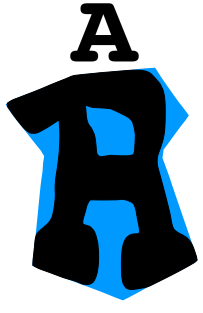
cost=0.333

cost=0.376

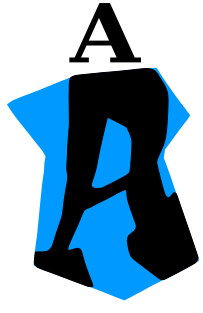
cost=0.469



cost=0.456



cost=0.36



cost=0.463

Rendering Styles

- Perturb boundaries of letters with random offsets.
- Fill letters with streamlines.

Rendering Styles

- Perturb boundaries of letters with random offsets.
- Fill letters with streamlines.

freedom & slavery

successful

Results

Results

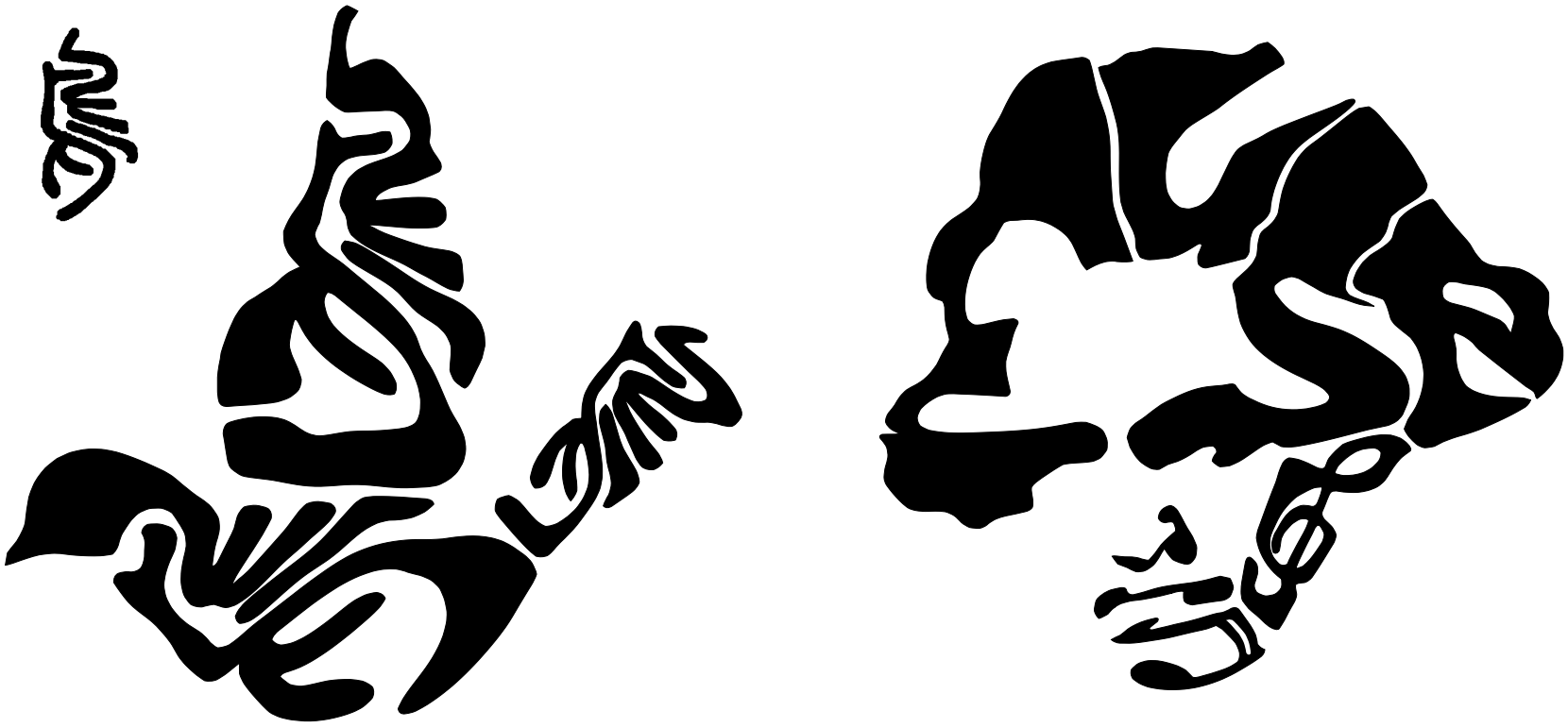
monalisa

Results

monalisa

lose & win

Results



Results

niao (bird)

Results

niao (bird)

muse

Results

Results

laugh & cry

Results

laugh & cry

graceful

Results

laugh & cry

graceful

Da Vinci code

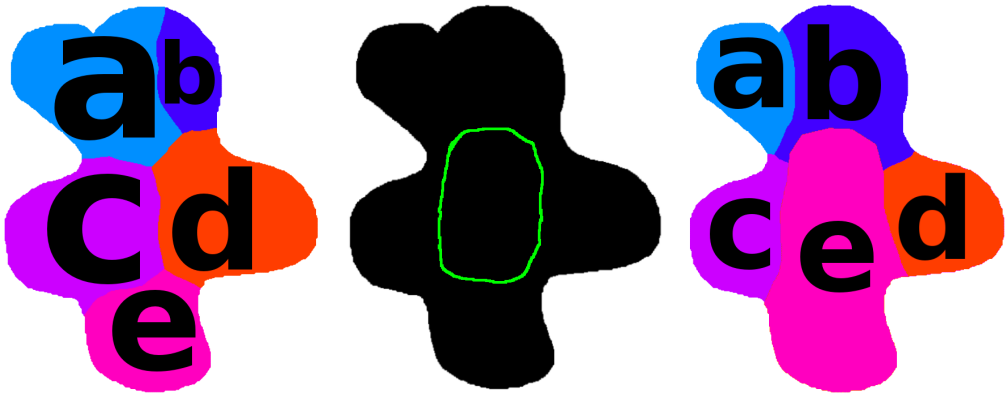
Conclusion and Future Work

- Distribute letters automatically.
- Improve the letter deformation model.

Questions?

User-Specified Subdivision

- User-specified clustering.



- User-specified exclusion.