# *Pen and Ink*



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## Binary shading, stencils and calligraphic packing

# *Binary Shading: Inspiration*

# *Binary shading: Techniques*

- Thresholding
  - Above -> white
  - Below -> black
  - Characteristics:
    - Noisy (real photos)
    - Edges (artificial)

# *Binary shading: Techniques*

- Thresholding
- Artistic Thresholding
  - Segmentation (graph)
  - Color assignment
  - Optimization (details)
  - Post-processing (edges)

  - Cost minimization

# *Binary shading: Techniques*

- Thresholding
- Artistic Thresholding
- Stylized B&W Images
  - Combined costs:
    - Local (detail layer)
    - Global (coarse layer)
  - Vectorized

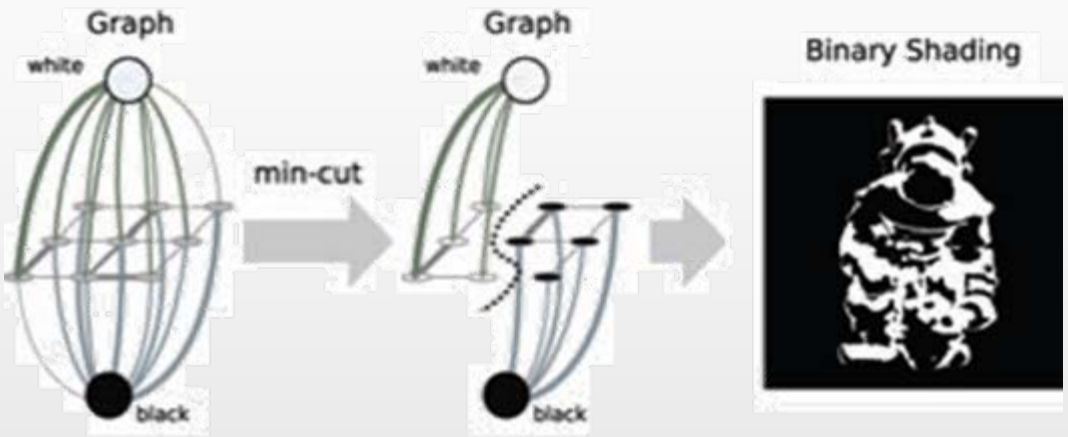
# *Binary Shading: Appearance+Geometry*

- Why?
  - Context: coherent dark areas are depicted in black despite high illumination, occluding contours
  - black or white because of:
    - the illumination of the shape
    - contrast between neighbor pixels
  - Artists make decisions for contradictory goals

# *Binary Shading: Appearance+Geometry*

- Solution:
  - Model process as an optimization problem
  - Graph cut energy minimization: compute the minimal cut (the globally minimal set of edges)

# *Binary Shading: Appearance+Geometry*




- Representation:
  - a node in the graph for each pixel
  - two terminal nodes (white: source node & black: sink node)
  - weighted connection to source or sink (appearance)
  - weighted connection between neighbour pixels (geometry)

# *Binary Shading: Appearance+Geometry*

- Procedure:
  - 1) Rendering (ray-tracing) – generate binary arrays:

$$\mathbf{A}_i \in [0,1]^{m \times n} \qquad \mathbf{G}_i \in [0,1]^{m \times n}$$

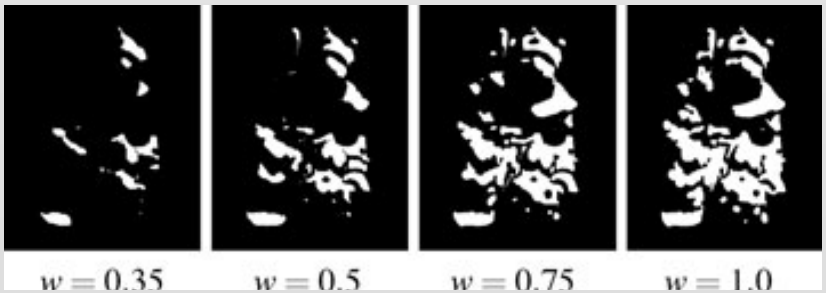
  - 2) Graph construction – assign weights:

$$W[x,y] = \sum_i w_i \, W_i[x,y],$$

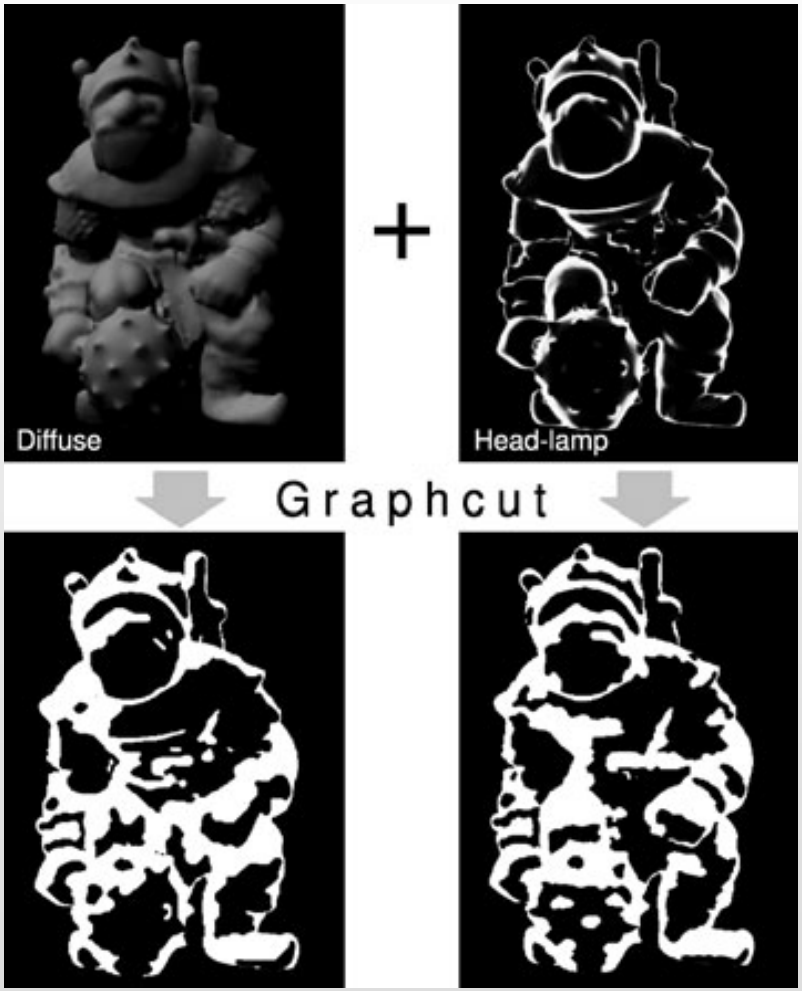
$$B[x,y] = \sum_i b_i \, B_i[x,y].$$

$$N[x_0, y_0, x_1, y_1] = \tilde{N} \prod_j N_j[x_0, y_0, x_1, y_1].$$

  - 3) Minimal cut – adjust & remove weights:

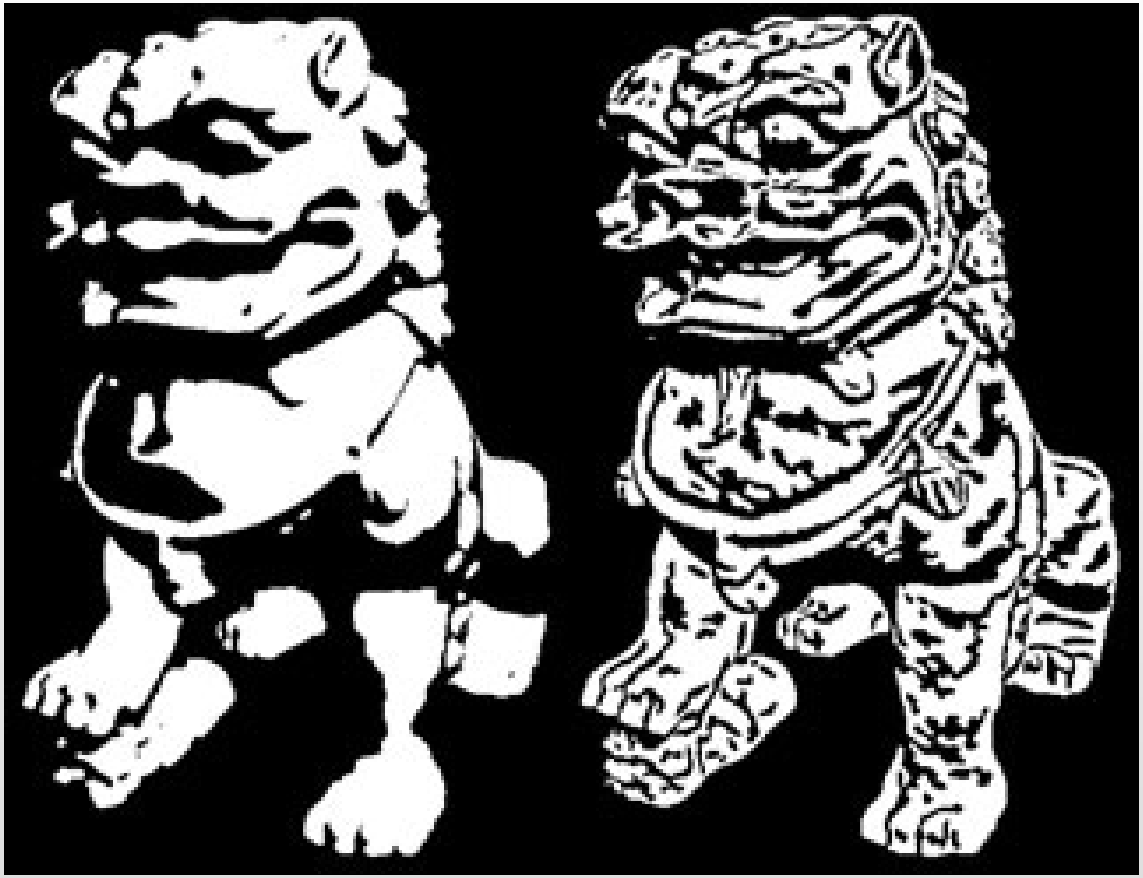



# *Binary Shading: Appearance+Geometry*




- Appearance arrays rendered from the 3D model:
- Diffuse
  - Lambertian reflection model, independent of viewpoint
- Specular
  - takes into account the viewing position
- Head lamp
  - helps separate the object from the background

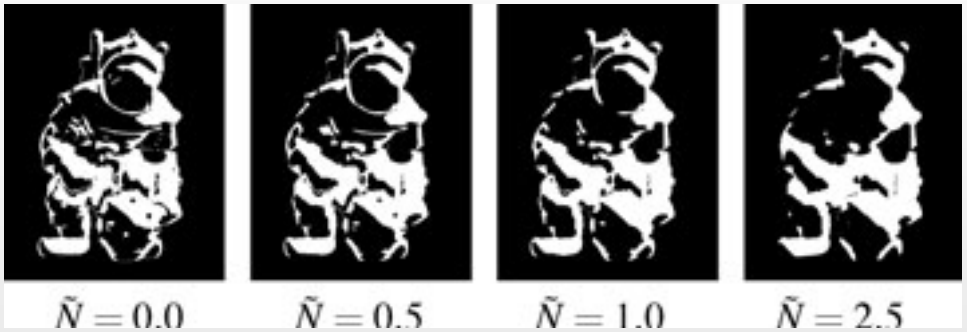
# *Binary Shading: Appearance+Geometry*

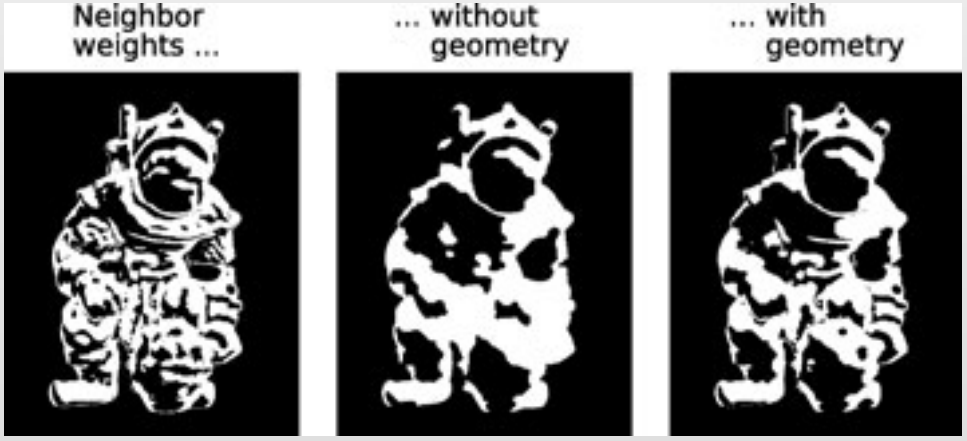


*Global (left) versus local (right) thresholding*

# *Binary Shading: Appearance+Geometry*

*Influence of edge weights: Small disconnected regions are successively connected when increasing weight*



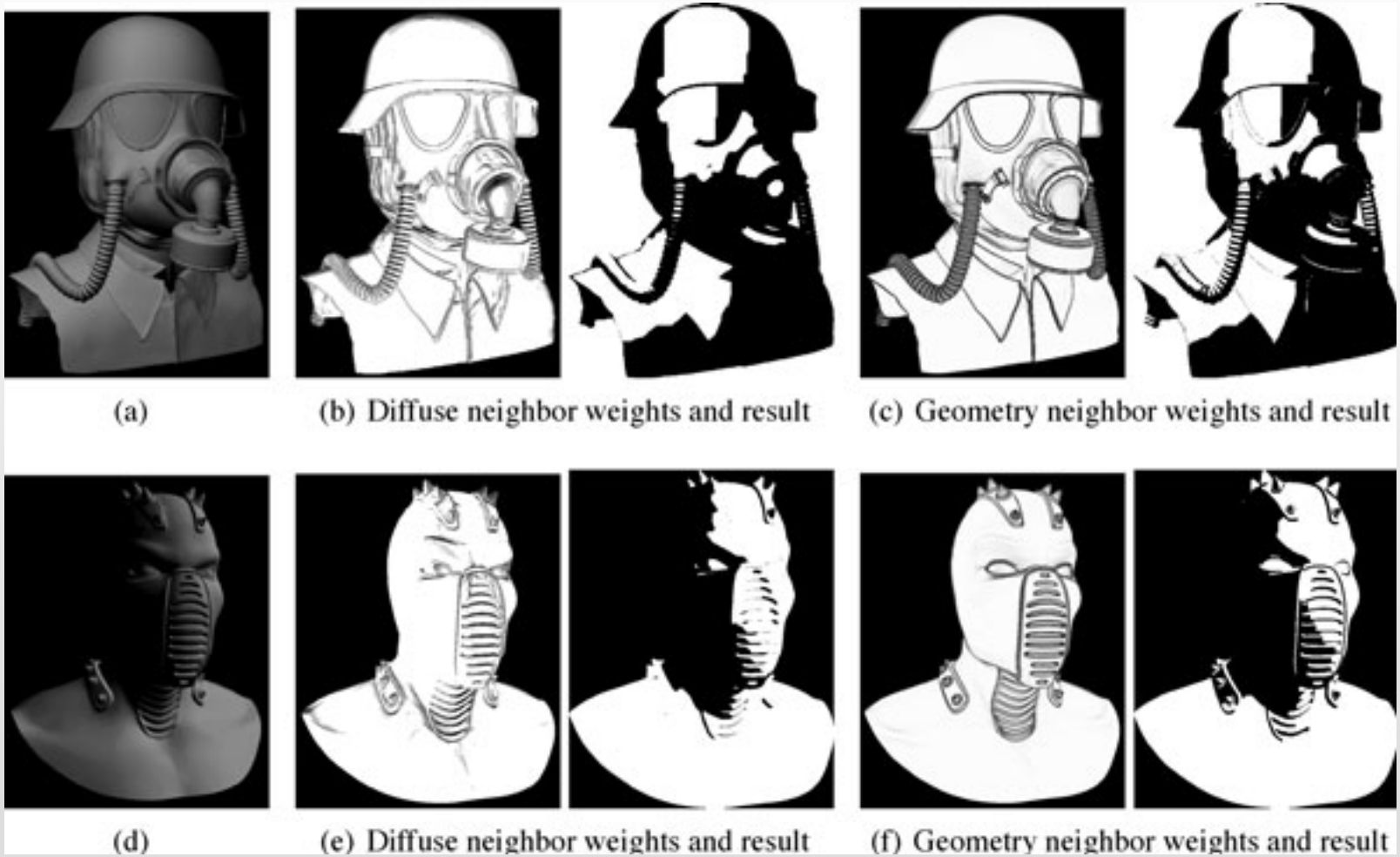




*thresholding* *˜N = 0.5* *Geometry modulation*

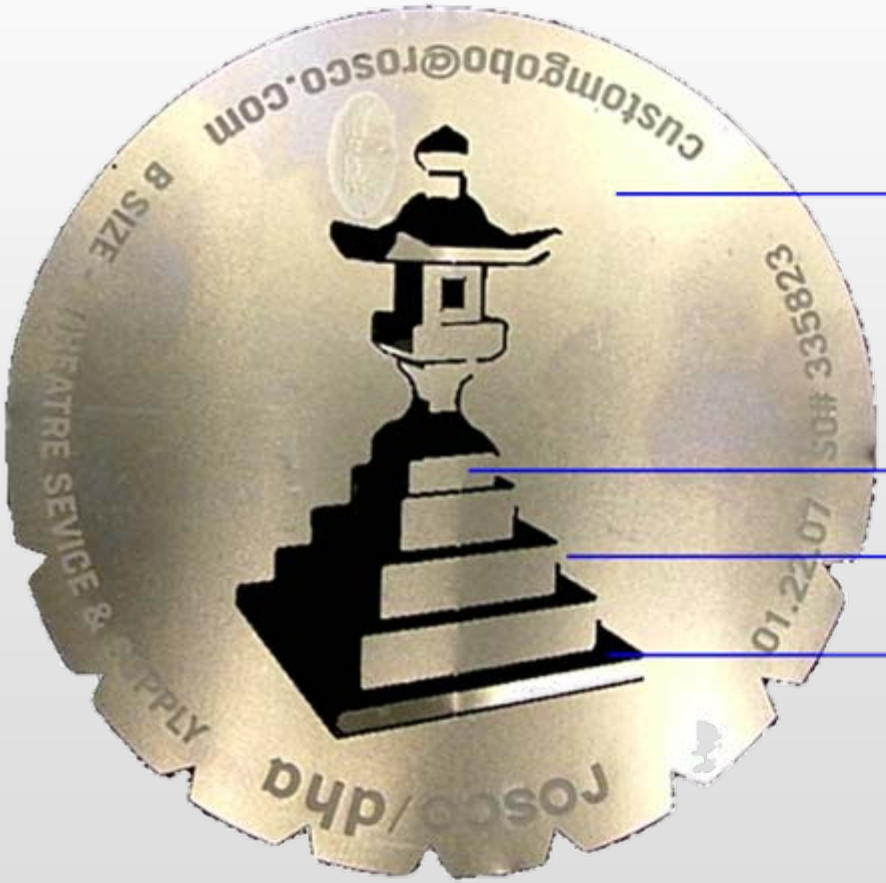
- Geometry array:
- Features:
  - Depth
  - Normal variation (curvature) relative to screen space
- Modulation

$$e^{-\frac{(z[x_0,y_0]-z[x_1,y_1])^2}{d^2}}$$

# *Binary Shading: Appearance+Geometry*



# *Binary shading: Stencils*




Stencil Template

Island (positive)

Bridge (positive)

Stencil Image (negative)

# *NPR Packing: Lloyd's method (Voronoi)*

# NPR Packing: Calligraphy

Calligraphic Packing:

Given a "container" and a sequence of letters L, construct a non-overlapping arrangement of deformed glyphs in the interior of the container so that:

1. The glyphs fill the container as much as possible;

2. Individual glyphs are recognizable as the corresponding letters; and

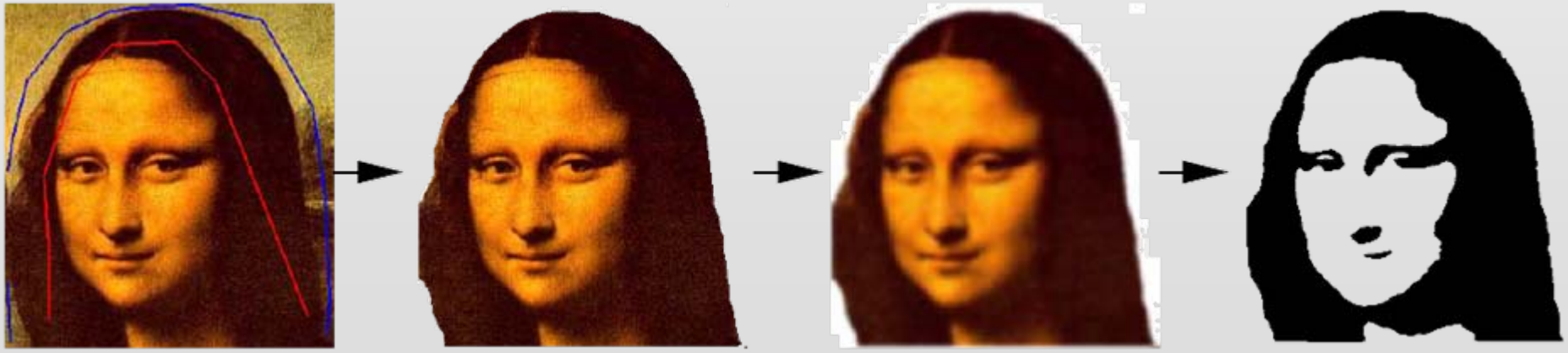
3. The order of the letters is suggested by the arrangement of the glyphs in the packing.

(a)

(b)

# *NPR Packing: Calligraphy*

- Approach:
  - Container extraction
  - Subdivision
  - Warping
  - * Rendering



# *NPR Packing: Calligraphy*

- Approach:
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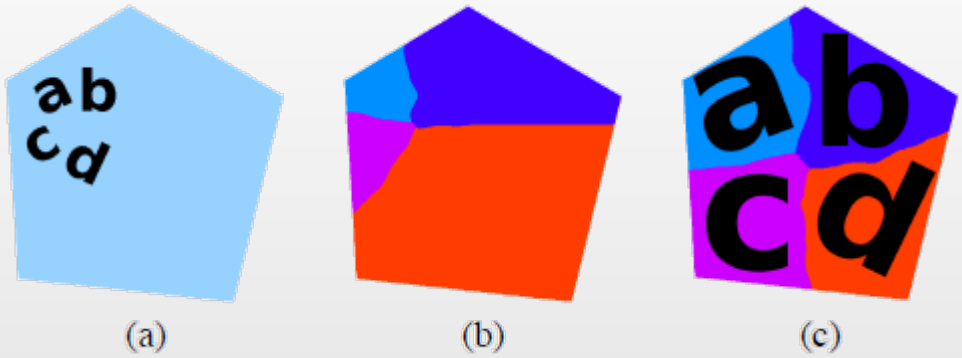
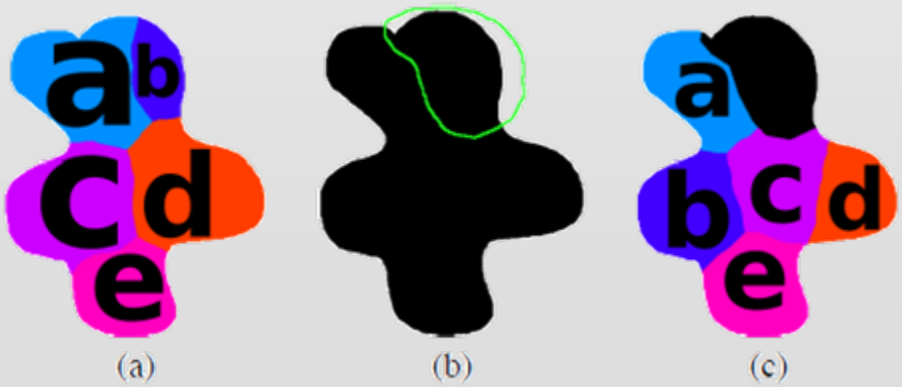
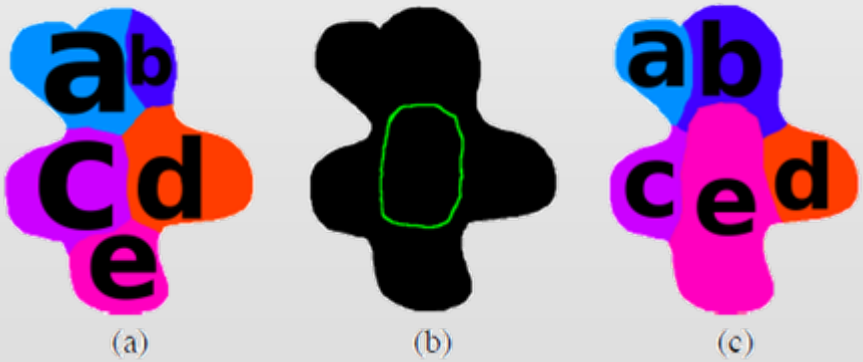
Initial positions and clustering result




Ignoring regions




Forcing clustering

# *NPR Packing: Calligraphy*

- Approach:
  - Container extraction
  - Subdivision
  - Warping
  - * Rendering

opening closing

# *NPR Packing: Calligraphy*

- Approach:
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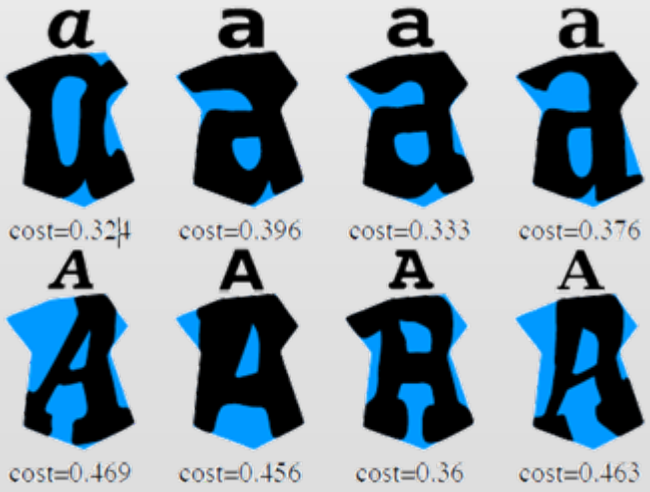


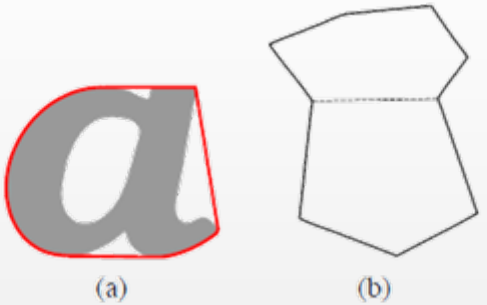



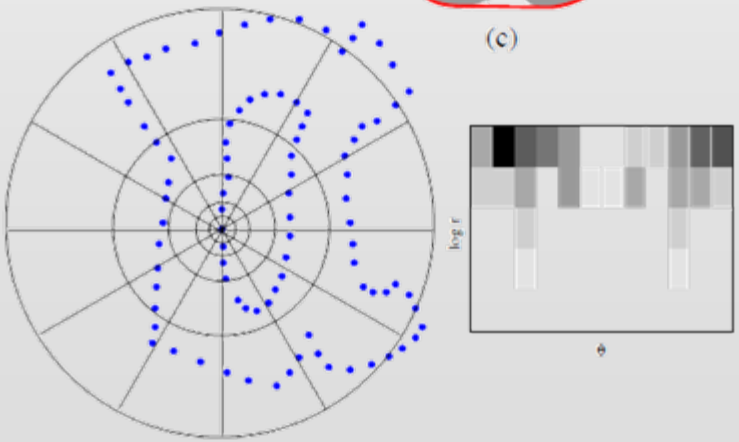

# *NPR Packing: Calligraphy*

- Approach:
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  - Subdivision
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# *NPR Packing: Calligraphy*

# *Pen & Ink*

- References:
  - Pen & Ink slides, Tobias Isenberg
  - Binary Shading Using Appearance and Geometry: Bert Buchholz, Tamy Boubekeur, Doug DeCarlo and Marc Alexa, COMPUTER GRAPHICS forum Volume 29 (2010), number 6 pp. 1981–1992
  - Calligraphic Packing: Jie Xu, Craig S. Kaplan, Graphics Interface, 2007

- Questions?