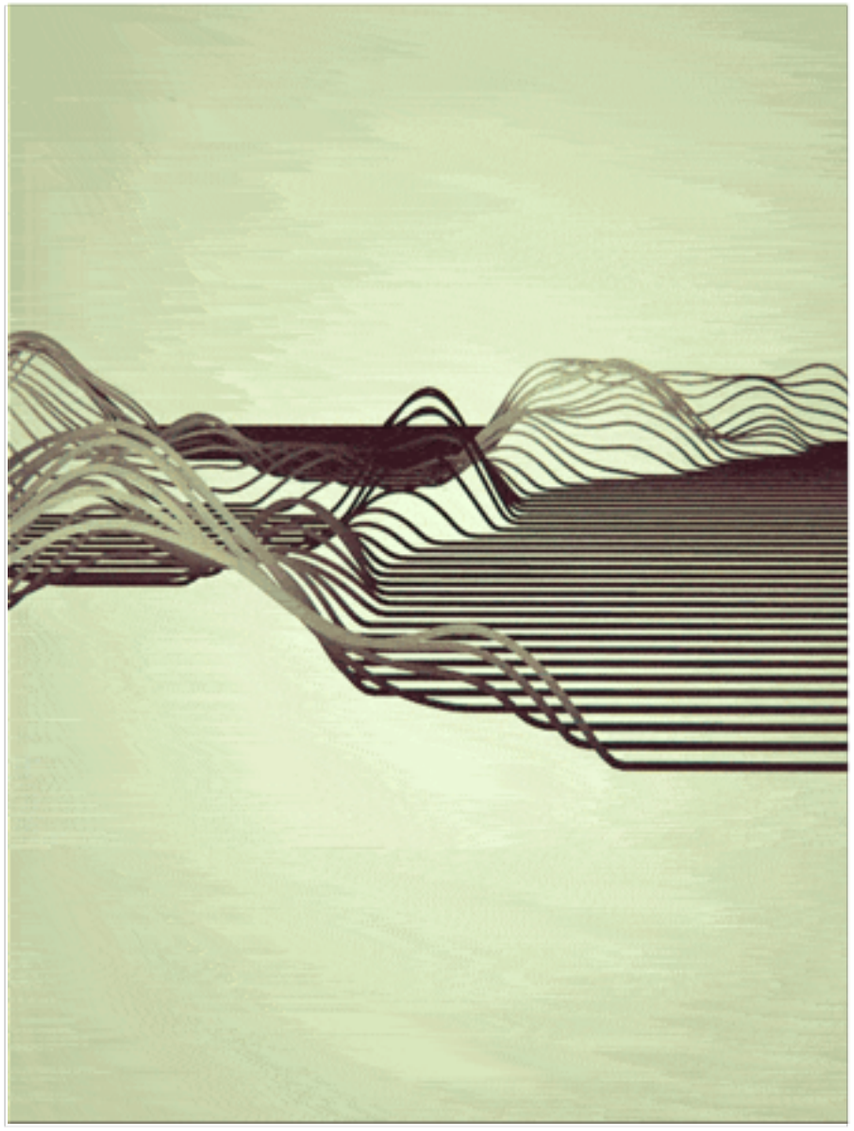


SHAPE REPRESENTATIONS

glizela taino

yixin lin

mark moyou

adrian peter

SHAPE RETRIEVAL

REFRESHER

QUERY SHAPE

DATABASE

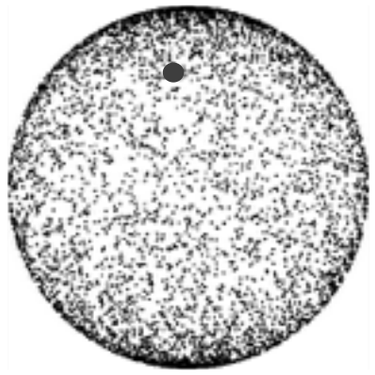
PROBLEM STATEMENT

SHAPE REPRESENTATION

1

FEATURE REPRESENTATION

2



RETRIEVAL MECHANICS

3

ROADMAP FOR FEATURE REPRESENTATION

1 WAVELETS

2 WAVELET DENSITY ESTIMATION

3 OPTIMIZATION

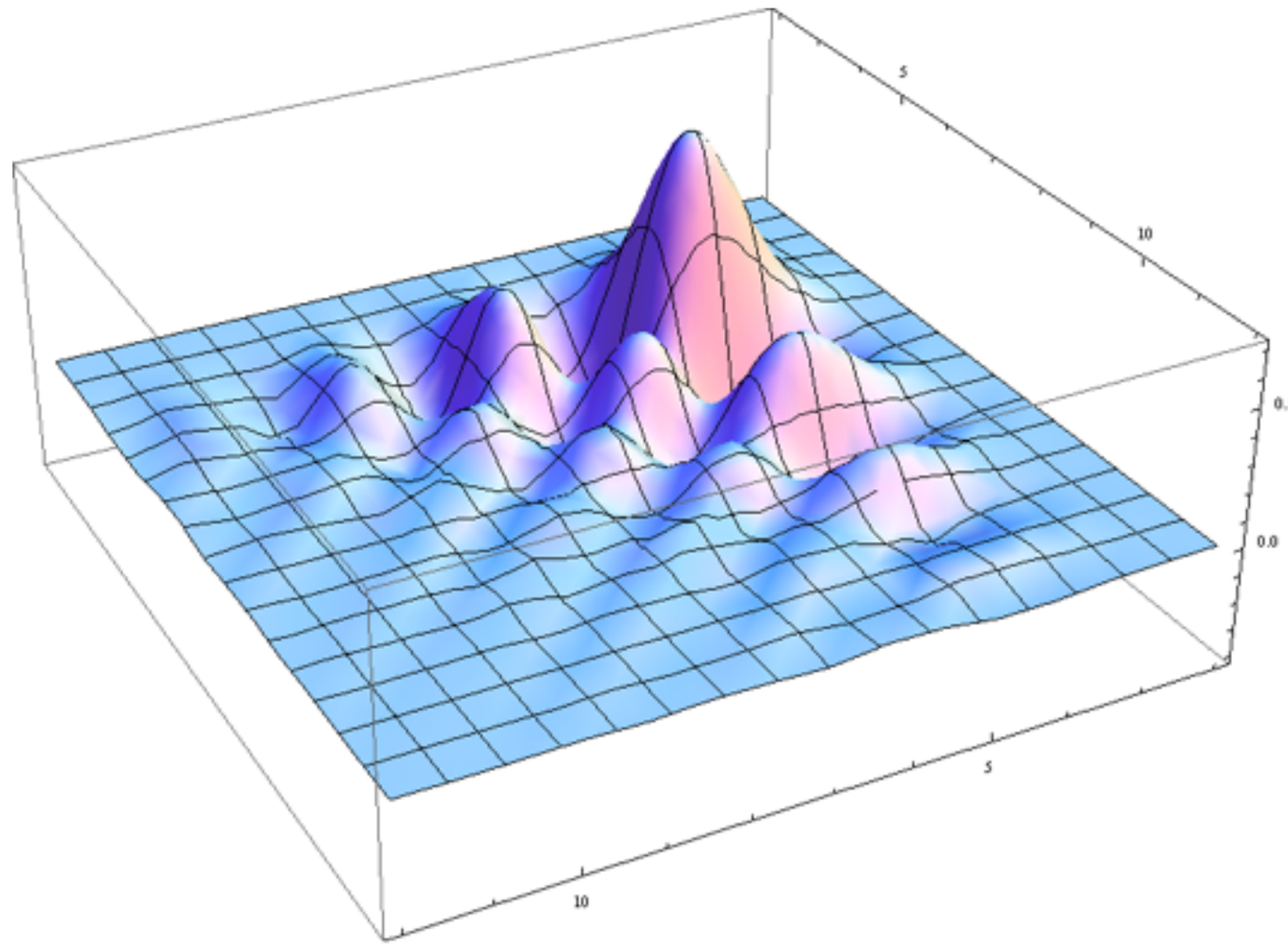
4 SHAPE L'ANE ROUGE

5 LINEAR ASSIGNMENT

6 RESULTS

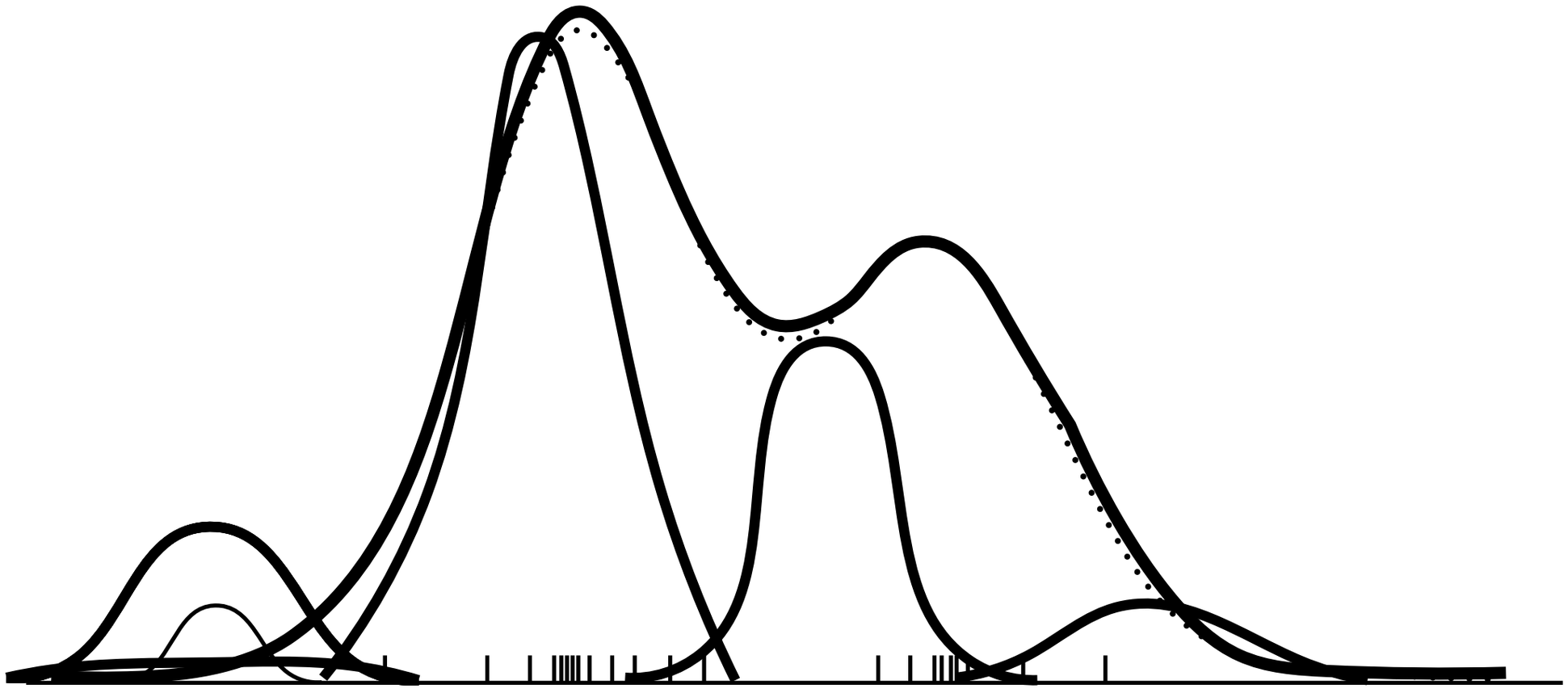
7 TIMELINE

WAVELETS



WHY WAVELETS

WAVELET DENSITY ESTIMATION



$\alpha_{j_0}\,\phi_{j_0,k}(x)$ $\alpha_{j_0}\,\phi_{j_0,k}(x)$ $\alpha_{j_0}\,\phi_{j_0,k}(x)$ $\alpha_{j_0}\,\phi_{j_0,k}(x)$

WAVELETS FORMALLY

$$\sqrt{p(x)} = \sum_{j_0,k} \underbrace{\alpha_{j_0,k}}_{\substack{\text{Scaling} \\ \text{Coefficient}}} \underbrace{\phi_{j_0,k}(x)}_{\substack{\text{Scaling Basis} \\ \text{Function}}} + \sum_{j \geq j_0,k}^{\infty} \underbrace{\beta_{j,k}}_{\substack{\text{Wavelet} \\ \text{Coefficient}}} \underbrace{\psi_{j,k}(x)}_{\substack{\text{Wavelet Basis} \\ \text{Function}}}$$

Father Mother

$$\phi\ \alpha_{j_o,\mathbf{k}} = \frac{1}{N} \frac{\sum_{i=1}^{N} \phi_{j_o,\mathbf{k}}(\mathbf{x})}{\sqrt{p(\mathbf{x})}} \quad 2)$$

$$\psi^2_{j,\mathbf{k}}(\mathbf{x}) = 2^j \psi \int \frac{}{\sqrt{p(x)}} \phi_{j_0,k}(x) dx \quad)$$

$$\psi^3_{j,\mathbf{k}}(\mathbf{x}) = 2^j \psi\, \mathcal{E}\left[\frac{\phi_{j_0,k}(x)}{\sqrt{p(x)}}\right]. \quad)$$

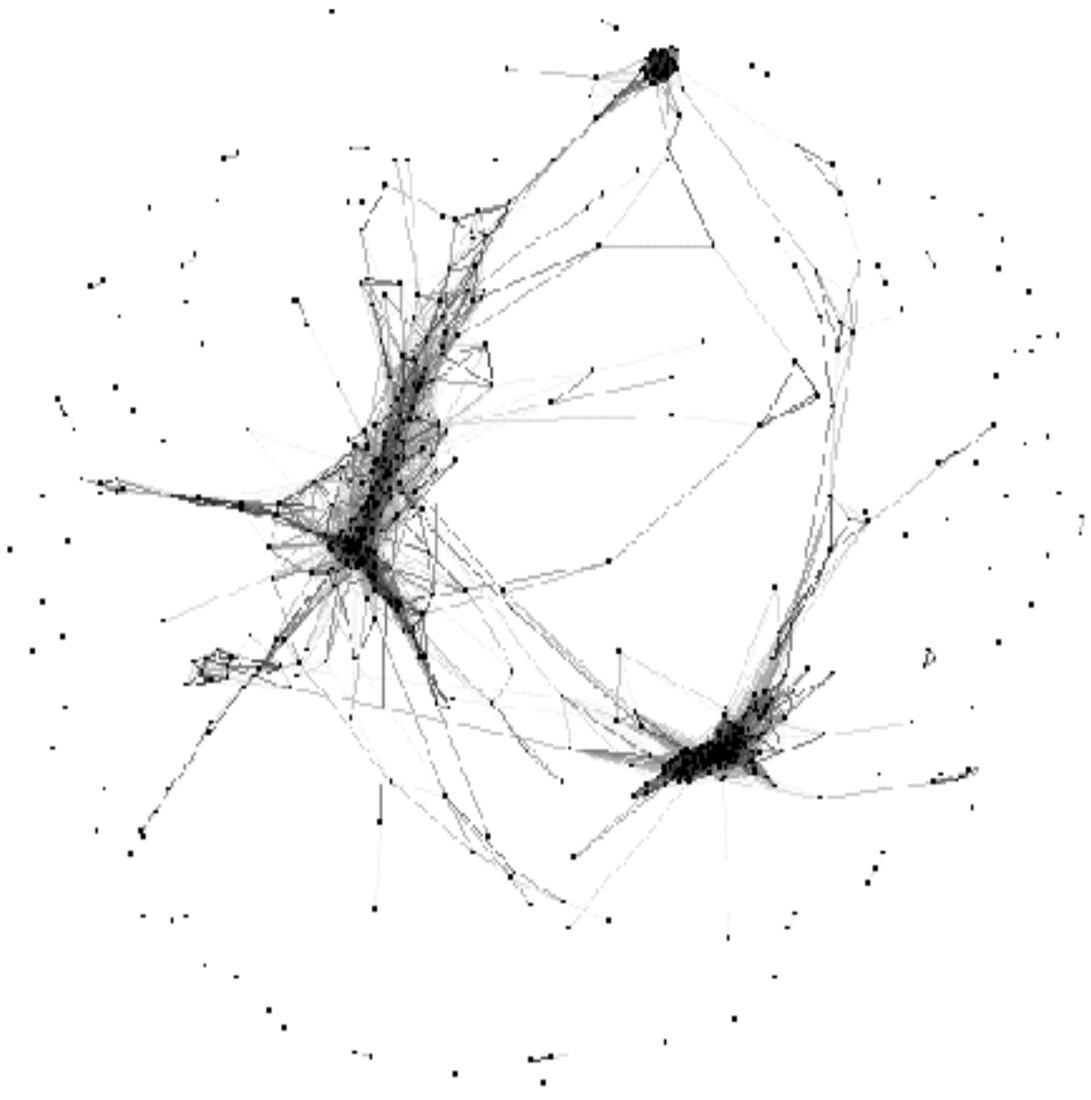
WAVELET DENSITY ESTIMATION

NEGATIVE LOG LIKELIHOOD

$$
\begin{aligned}
-\log p(X;\{\alpha_{j_0,k},\beta_{j,k}\}) &= -\frac{1}{N}\log\prod_{i=1}^{N}\left[\sqrt{p(x_i)}\right]^2 \\
&= -\frac{1}{N}\sum_{i=1}^{N}\log\left[\sum_{j_0,k}\alpha_{j_0,k}\phi_{j_0,k}(x_i)+\sum_{j\geq j_0,k}^{j_1}\beta_{j,k}\psi_{j,k}(x_i)\right]^2
\end{aligned}
$$

$$
\sum_{j_0,k}\alpha_{j_0,k}^2+\sum_{j\geq j_0,k}^{j_1}\beta_{j,k}^2=1.
$$

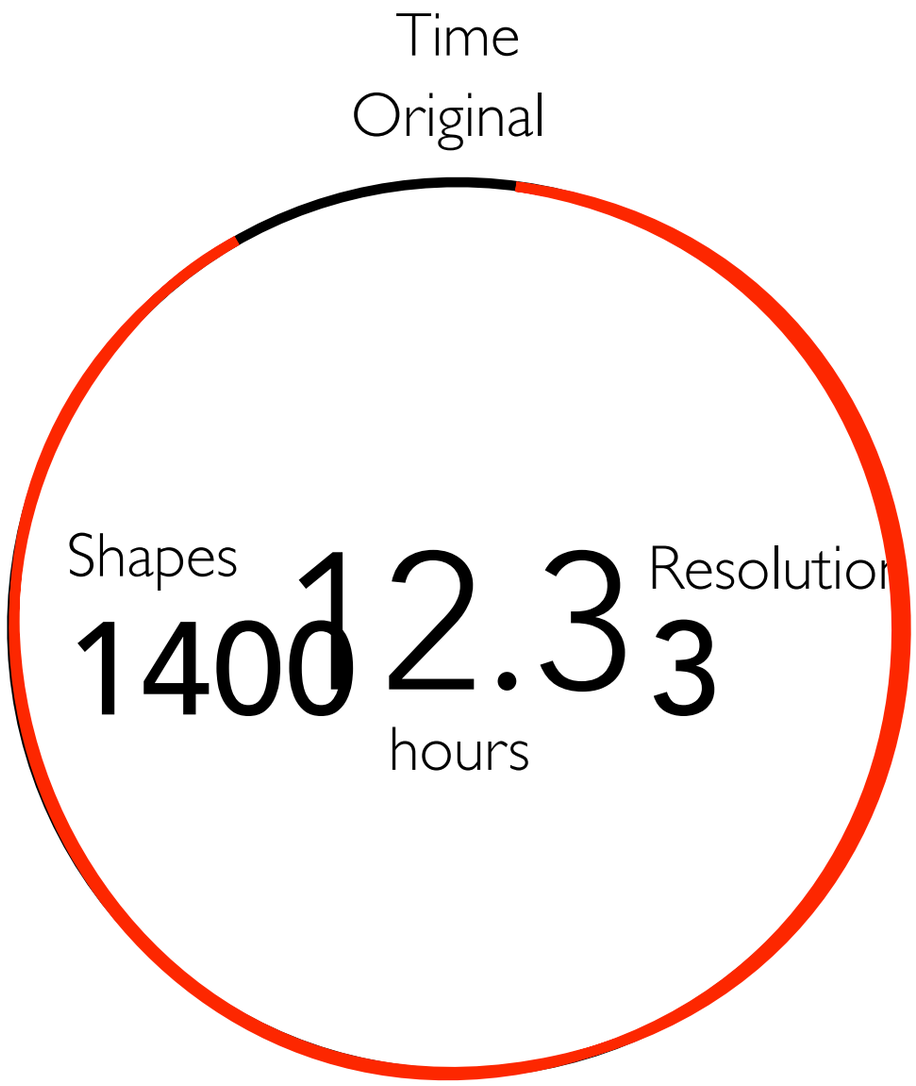
WAVELET DENSITY ESTIMATION



WAVELET-BASED SPECTRAL ESTIMATION

WDE OPTIMIZATION ⏱

Database
MPEG7



Translations
576

WDE OPTIMIZATION

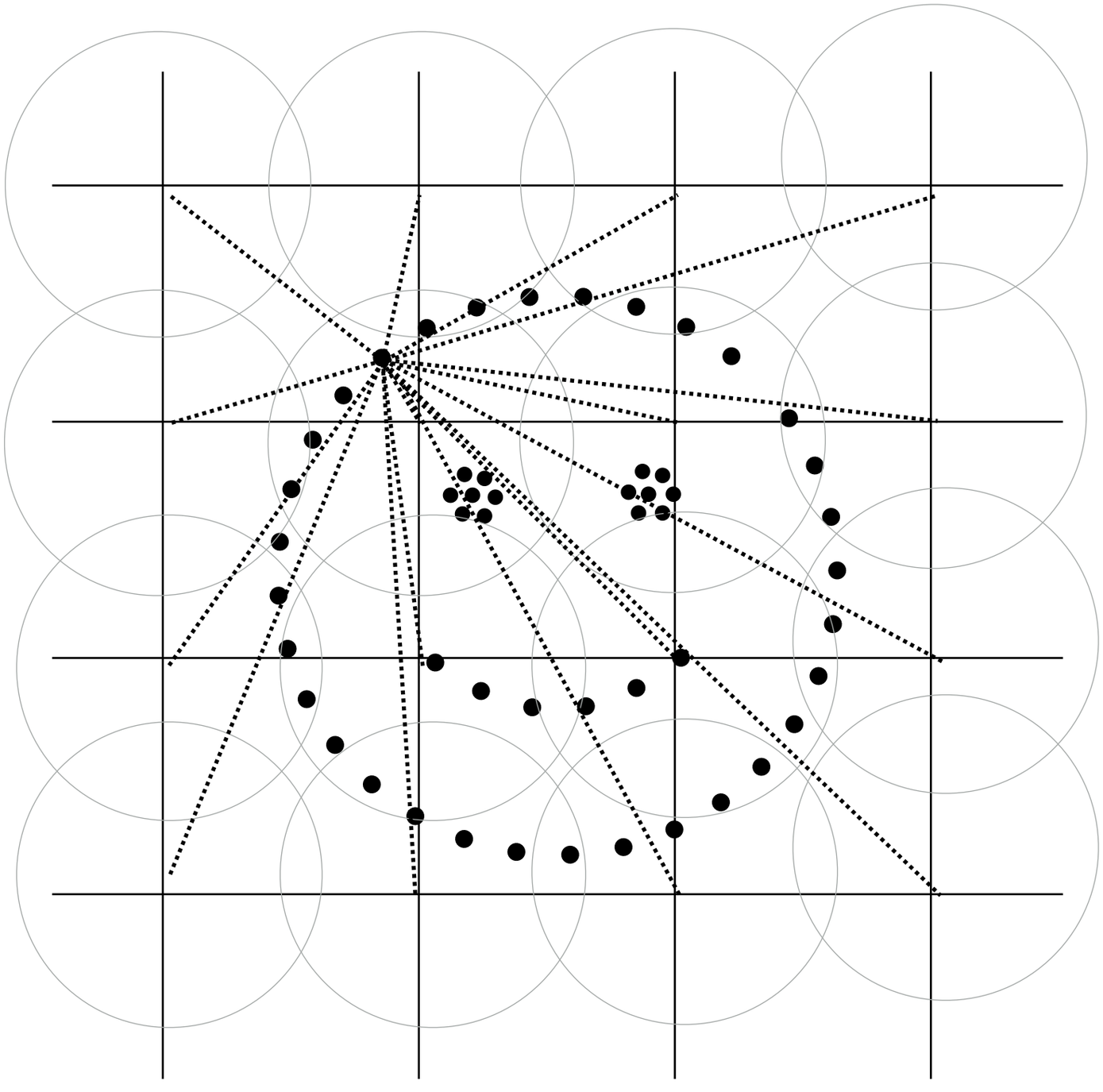
INITIALIZE COEFFICIENTS PROBLEM

$$\alpha_{j_o,\mathbf{k}} = \frac{1}{N} \frac{\sum_{i=1}^{N} \phi_{j_o,\mathbf{k}}(\mathbf{x})}{\sqrt{p(\mathbf{x})}}$$

576 wavelet functions

× 4007 samples

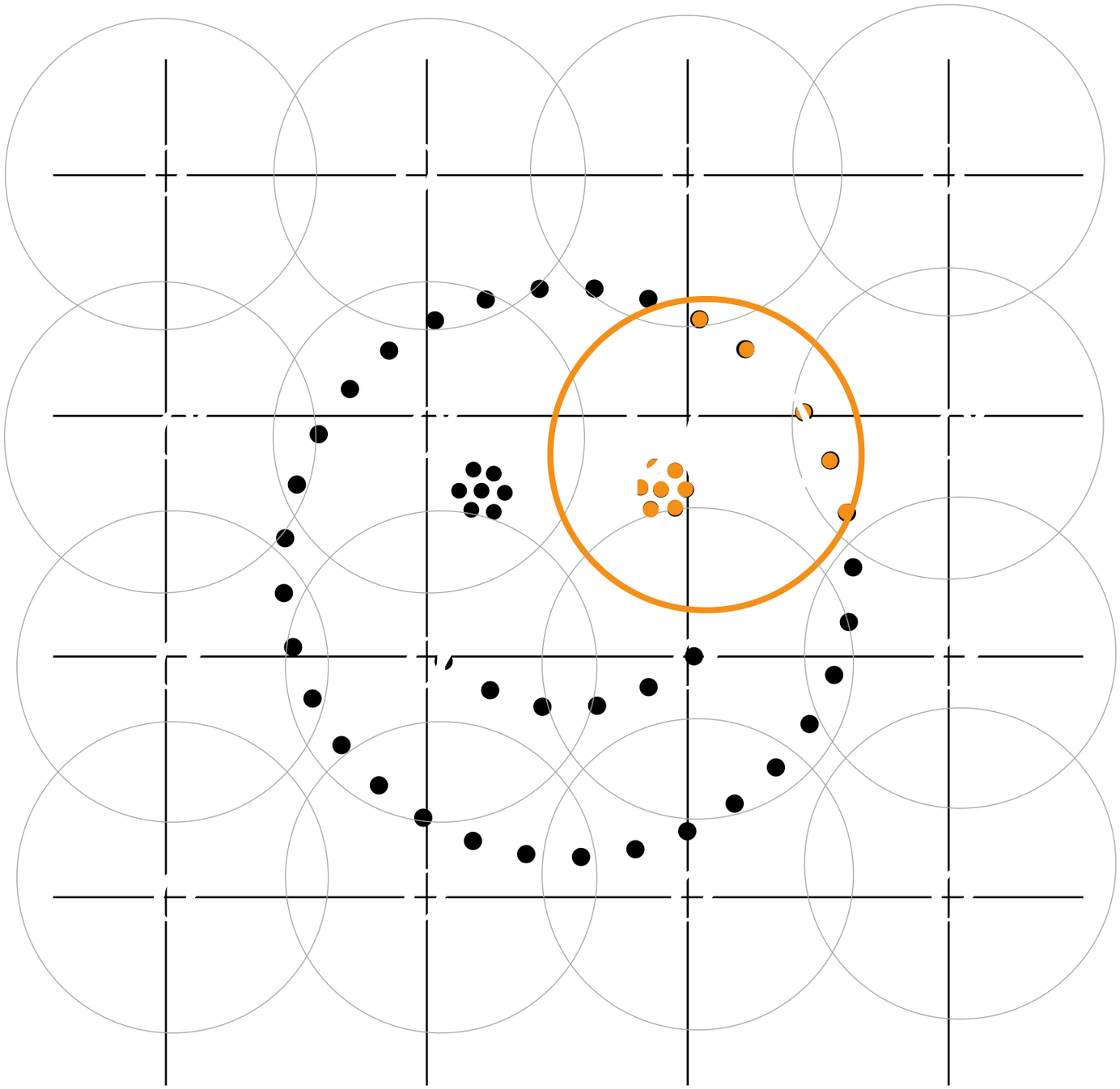
2,308,032 operations



WDE OPTIMIZATION

INITIALIZE COEFFICIENTS SOLUTION

$$\alpha_{j_o,\mathbf{k}} = \frac{1}{N} \frac{\sum_{i=1}^{N} \phi_{j_o,\mathbf{k}}(\mathbf{x})}{\sqrt{p(\mathbf{x})}}$$

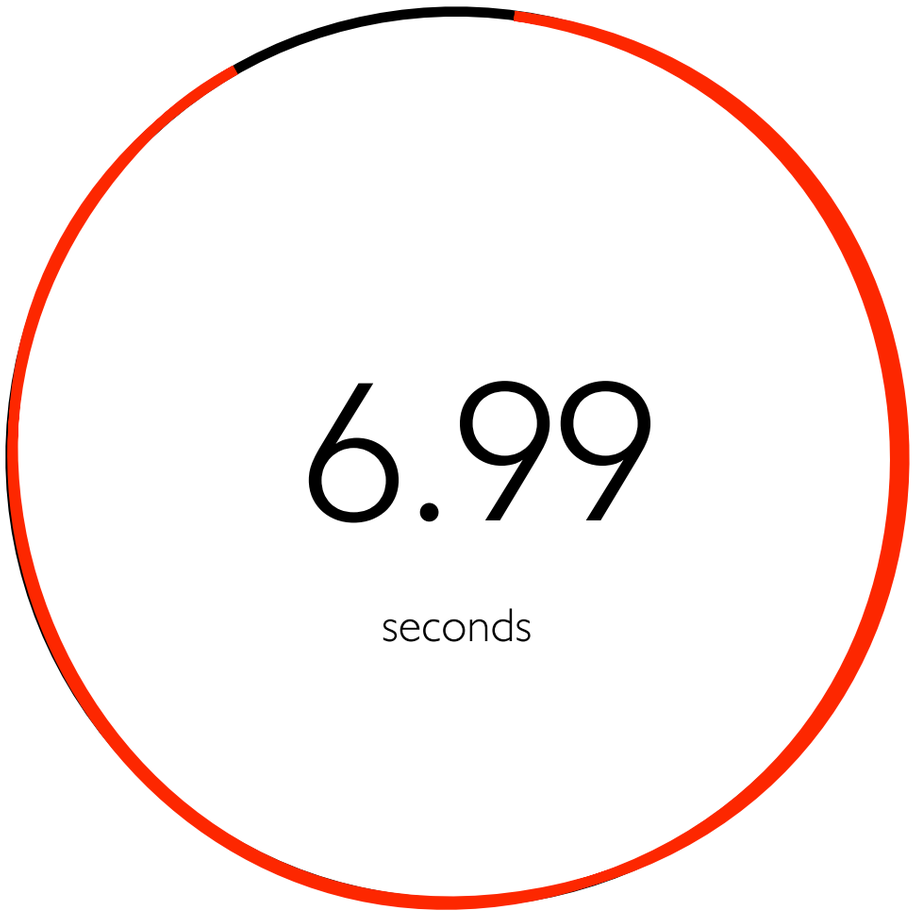


WDE OPTIMIZATION

INITIALIZE COEFFICIENTS

Time

Original



Time

Optimized

99.2%

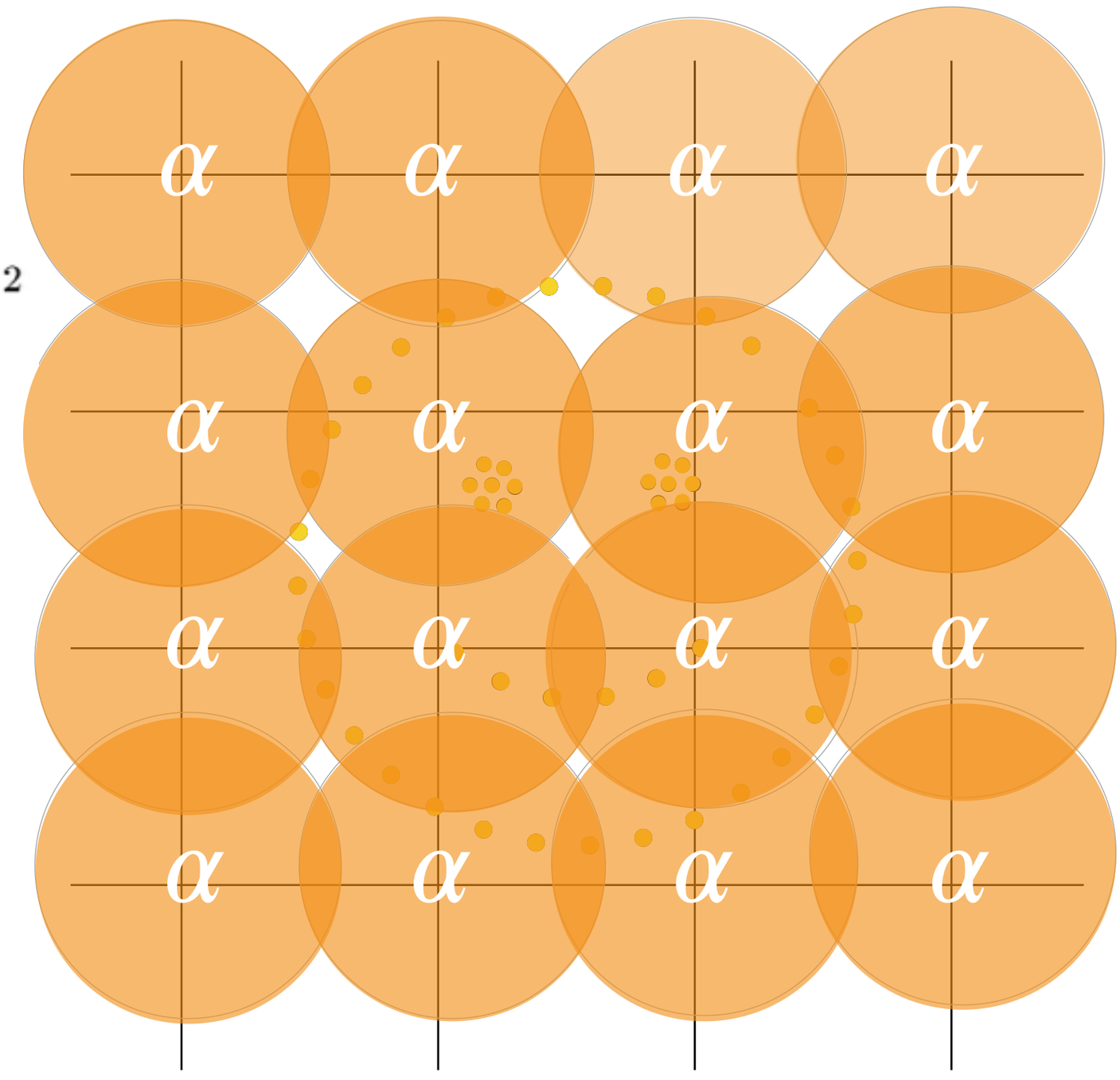
faster

WDE OPTIMIZATION

NEGATIVE LOG LIKELIHOOD SOLUTION

$$-\log p(X;\{\alpha_{j_0,k},\beta_{j,k}\})$$

$$= -\frac{1}{N}\sum_{i=1}^{N}\log\left[\sum_{j_0,k}\alpha_{j_0,k}\phi_{j_0,k}(x_i)\right]^2$$



WDE OPTIMIZATION

NEGATIVE LOG LIKELIHOOD

Time

Original

94.5%

faster

Time

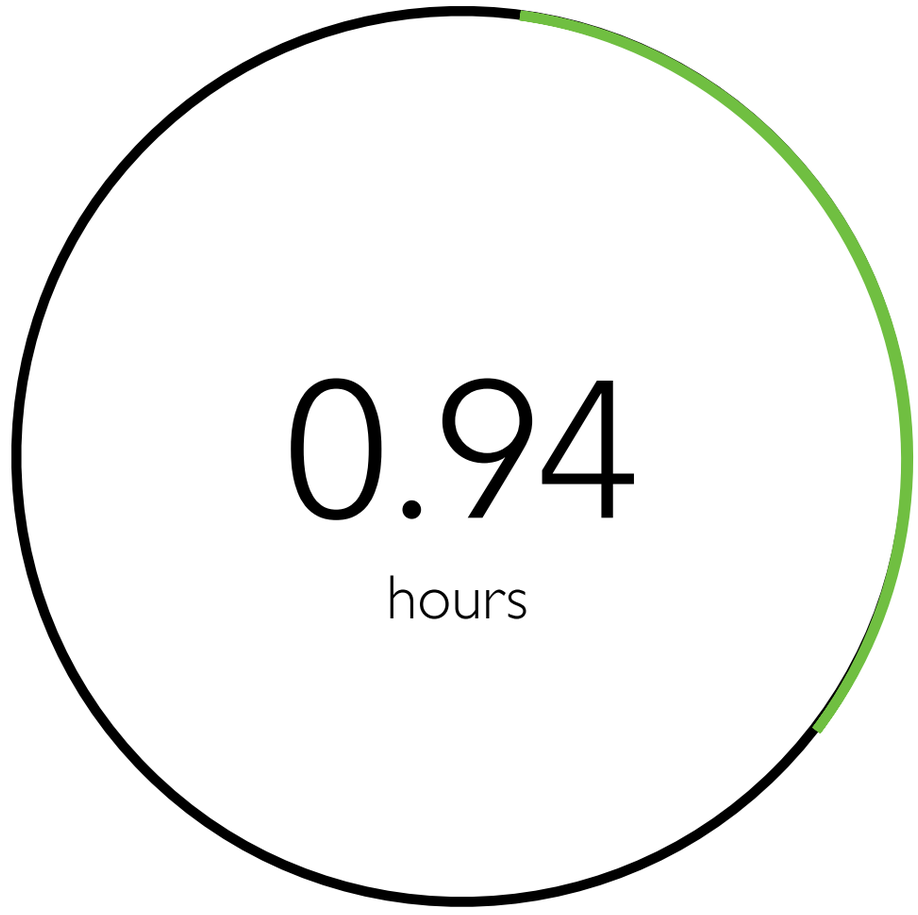
Optimized

WDE OPTIMIZATION

Time
Original

92.4%
faster

Time
Optimized



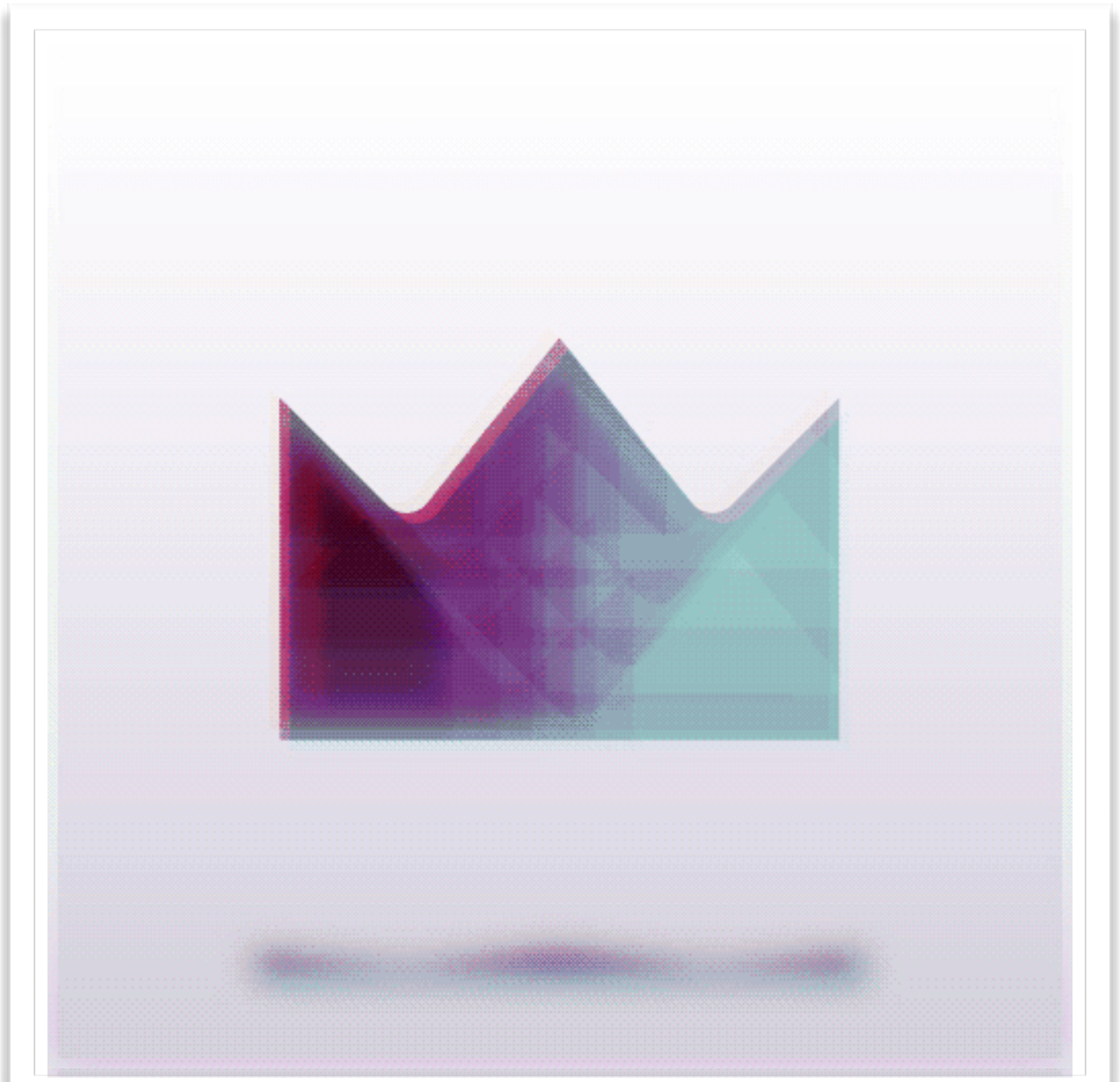
Database
MPEG7

Shapes
1400

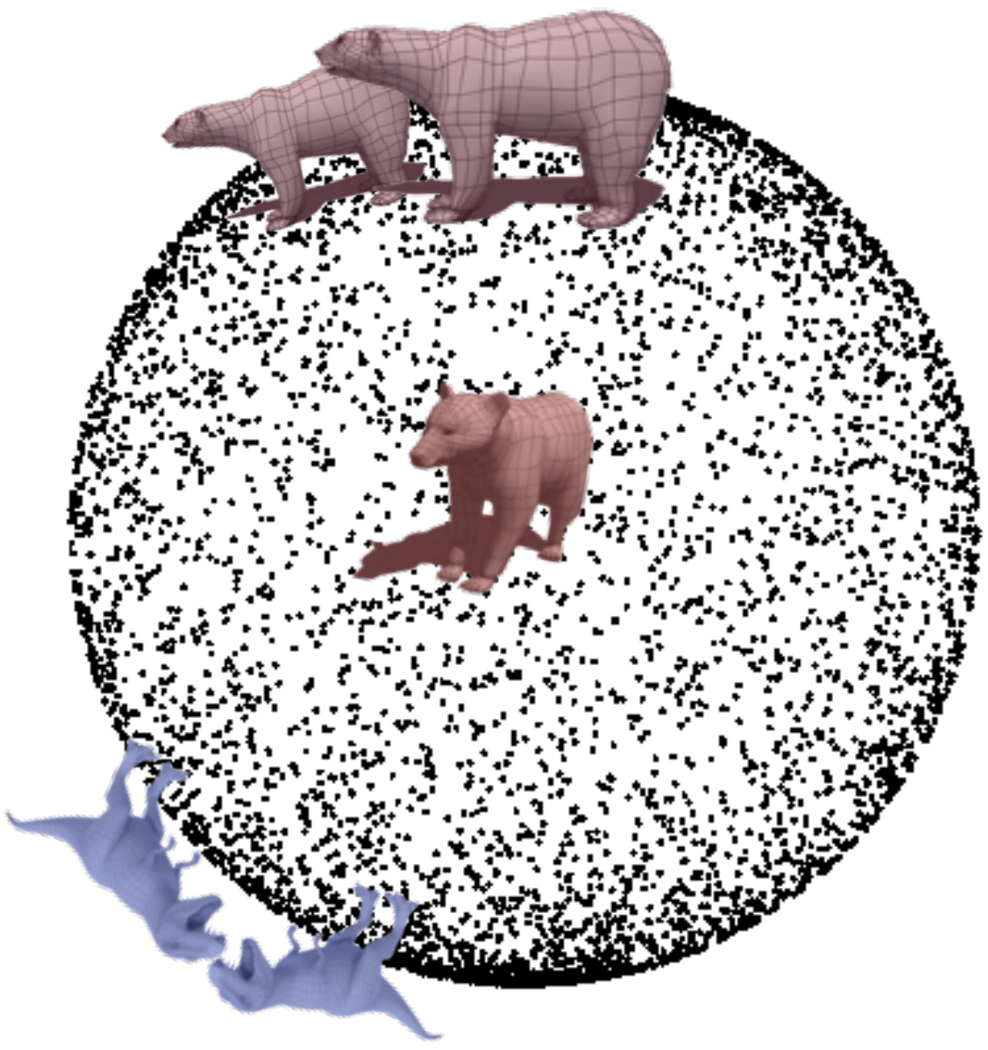
Resolution
3

Translations
576

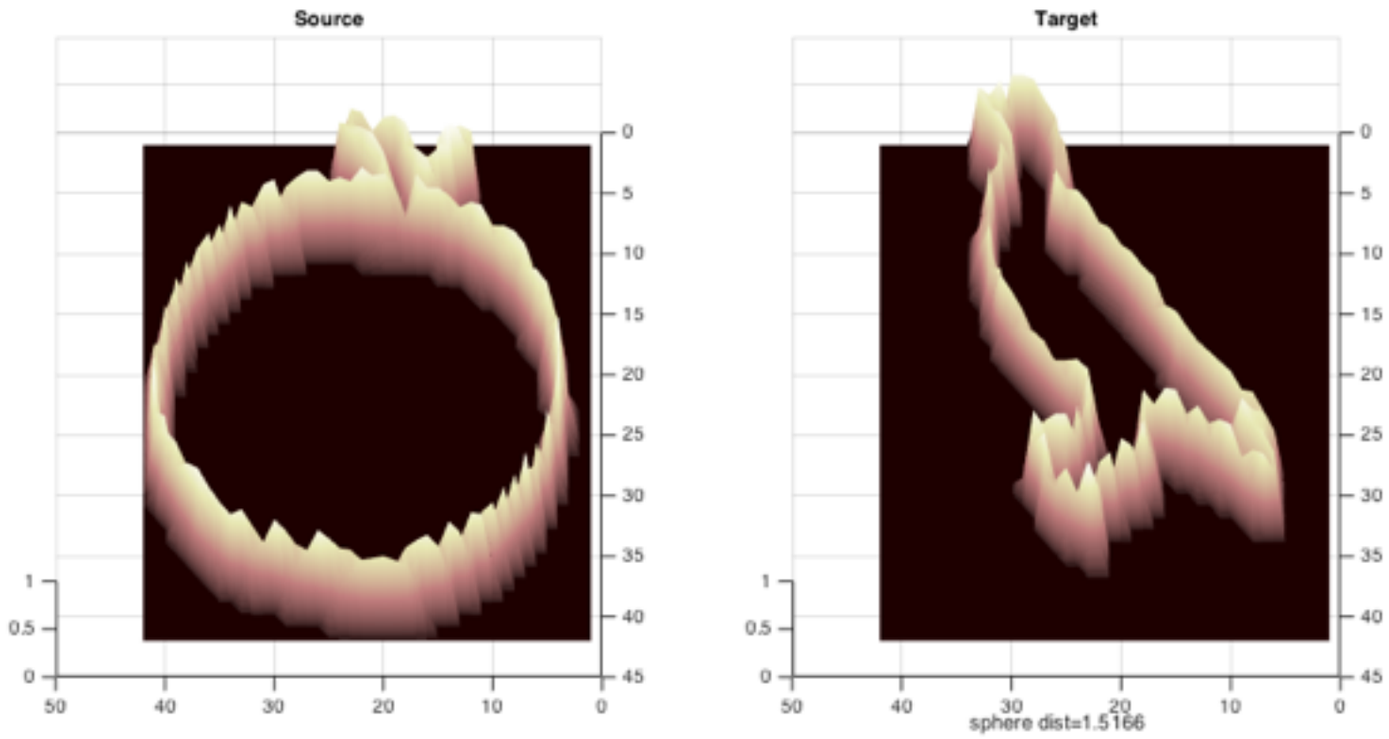
SHAPE L'ANE ROUGE



SHAPE L'ANE ROUGE

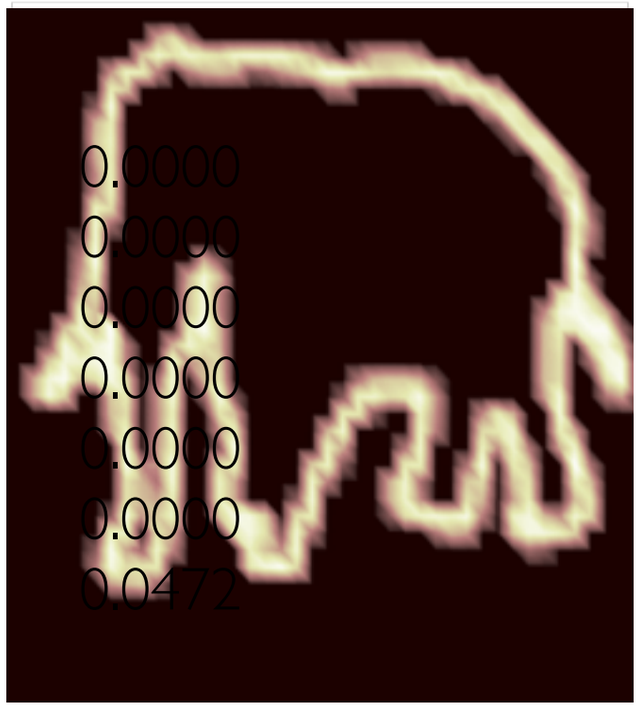


SHAPE L'ANE ROUGE

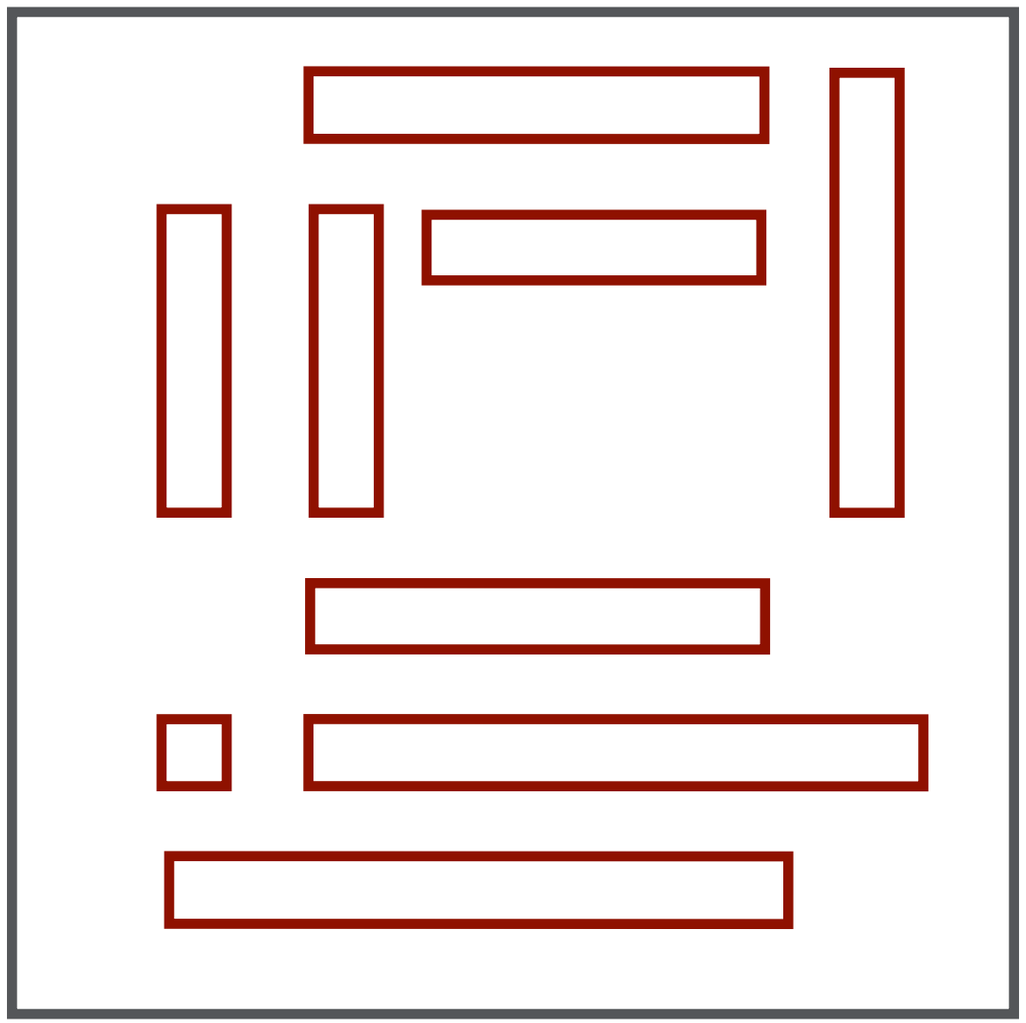


SHAPE L'ANE ROUGE

0.0000	0.0000	0.0000
0.0000	0.0000	0.0000
0.0000	0.0000	0.0000
0.0000	0.0361	0.0000
0.0000	0.0000	0.0000
0.0000	0.0000	0.0000
0.0000	0.0000	0.0472

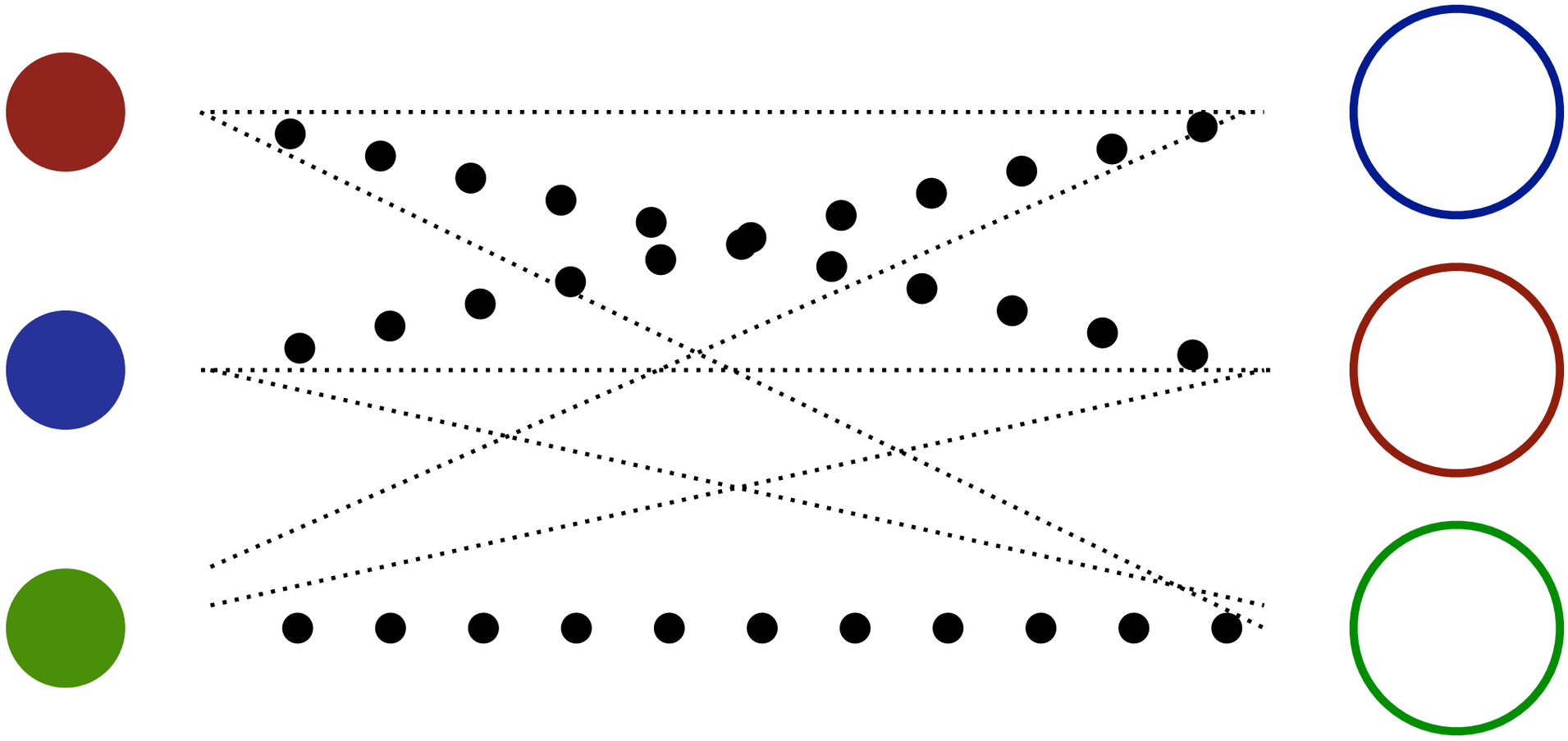


SHAPE L'ANE ROUGE



SHAPE L'ANE ROUGE

LINEAR ASSIGNMENT



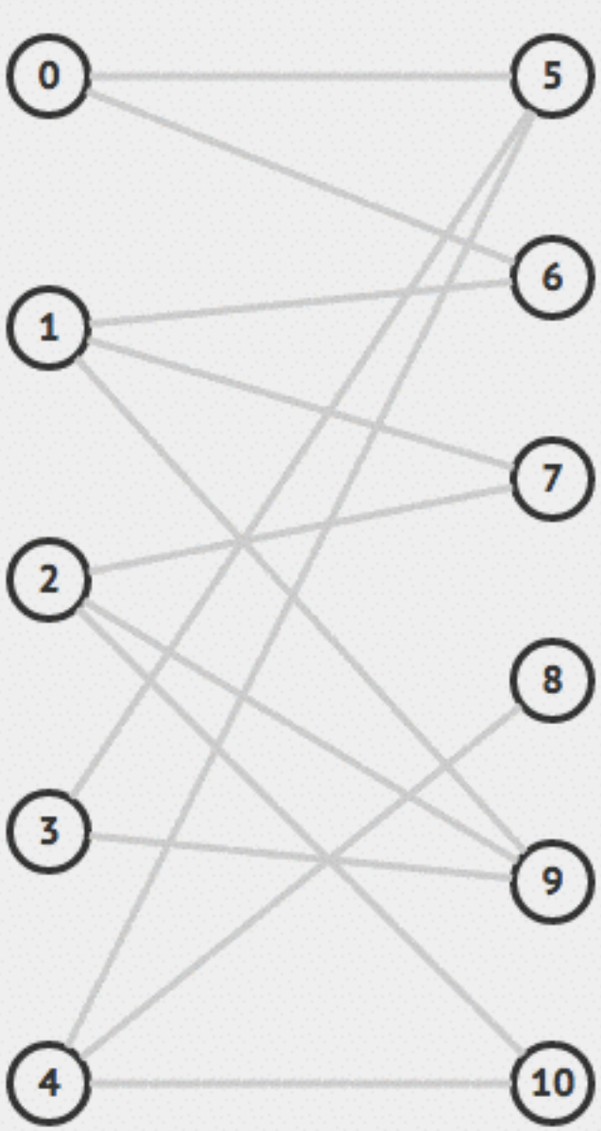
SHAPE L'ANE ROUGE

LINEAR ASSIGNMENT, FORMALLY

$$\mathrm{s}X, Y\| = |Y|$$

$$C : X \times Y \to \mathbb{R}$$

$$X \to Y$$

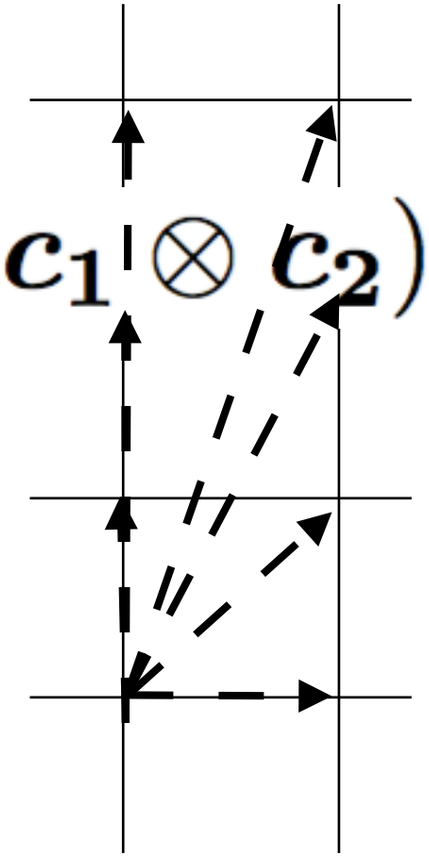


SHAPE L'ANE ROUGE

JONKER-VOLGENANT

SHAPE L'ANE ROUGE

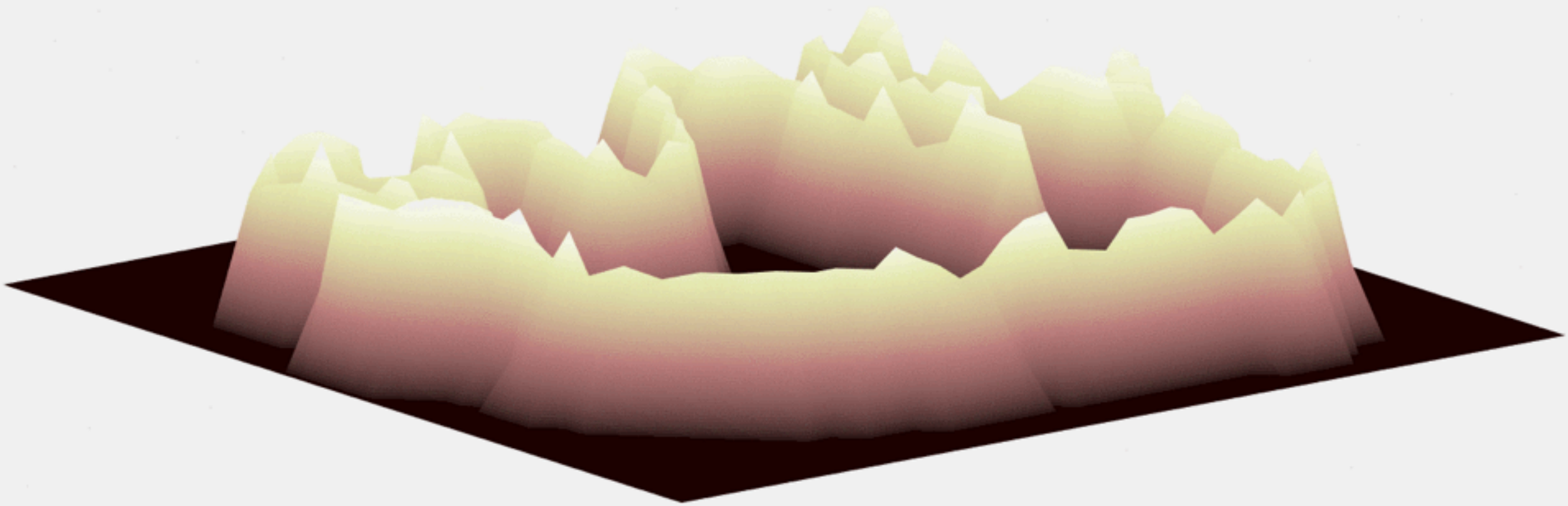
COST MATRIX



$$C = -(\boldsymbol{c_1} \otimes \boldsymbol{c_2}) + D$$

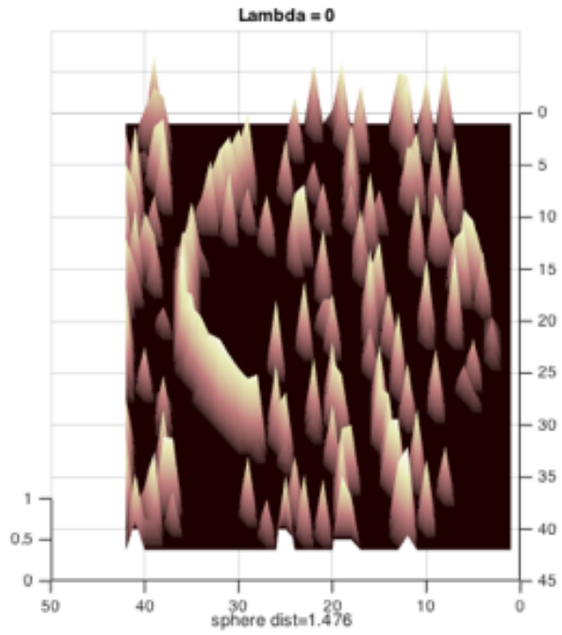
SHAPE L'ANE ROUGE

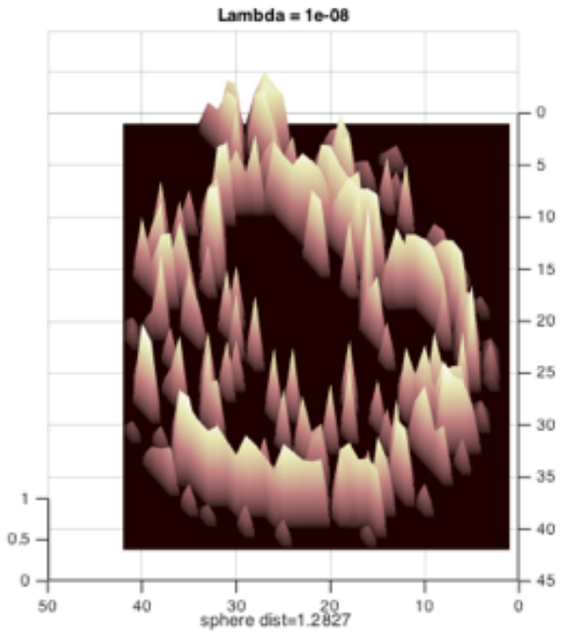
OPTIMIZATION FOR JONKER-VOLGENANT

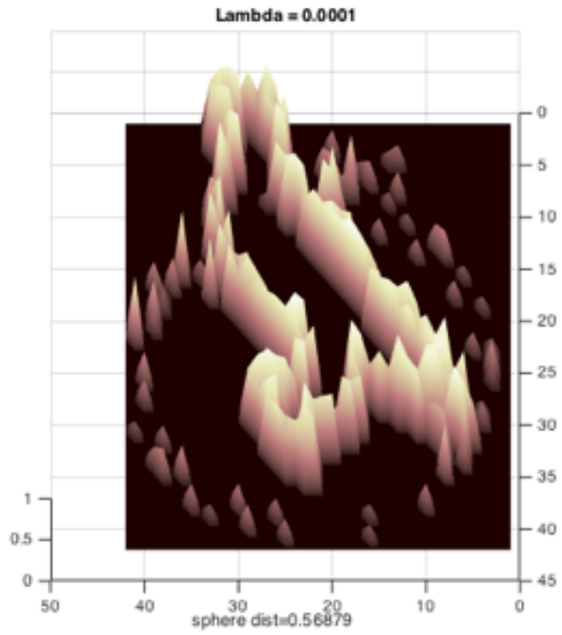


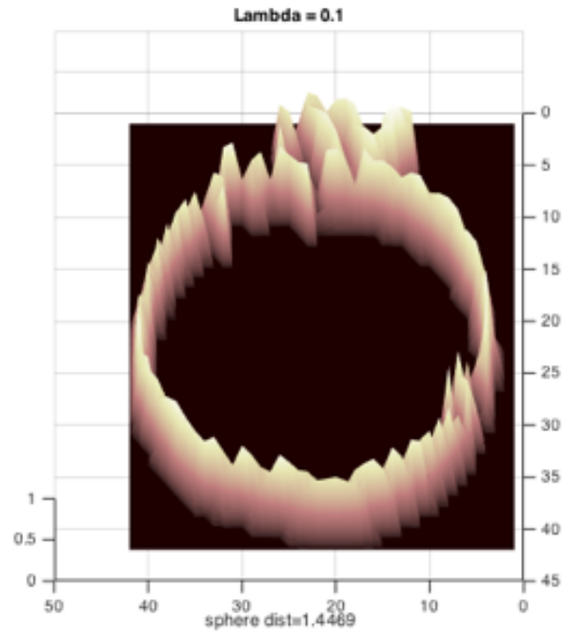
SHAPE L'ANE ROUGE

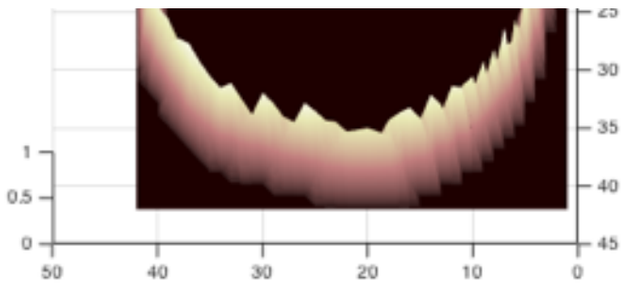
DIFFERENT SHAPE WARP

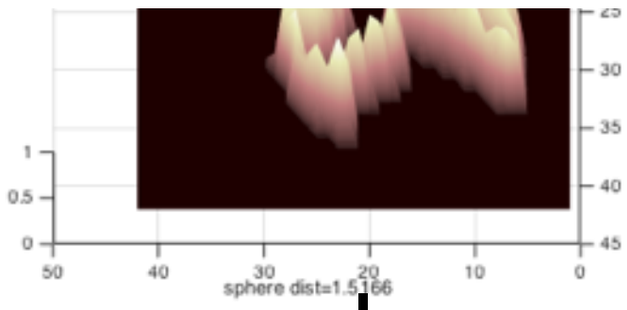








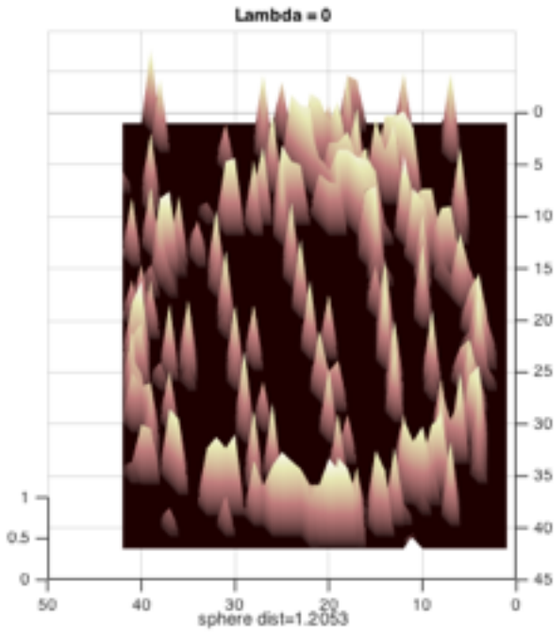


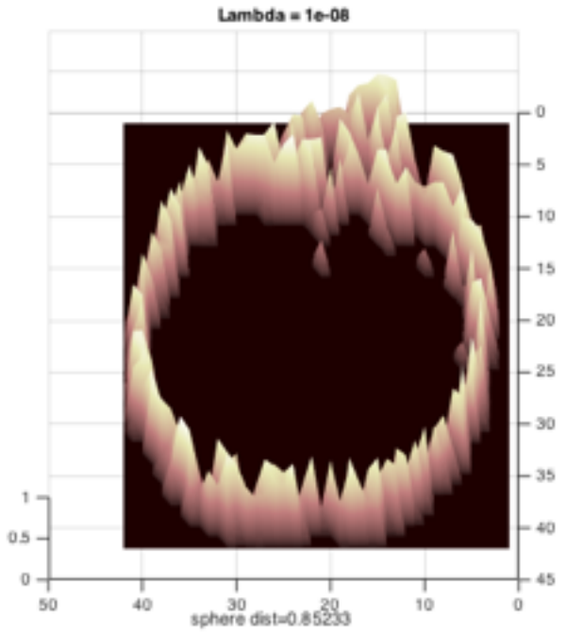


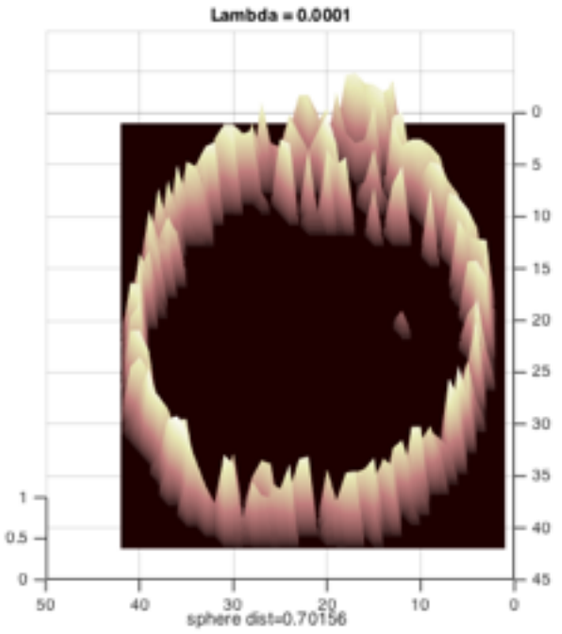
$$\frac{1}{\lambda}$$ ·····▶ MOVEMENT

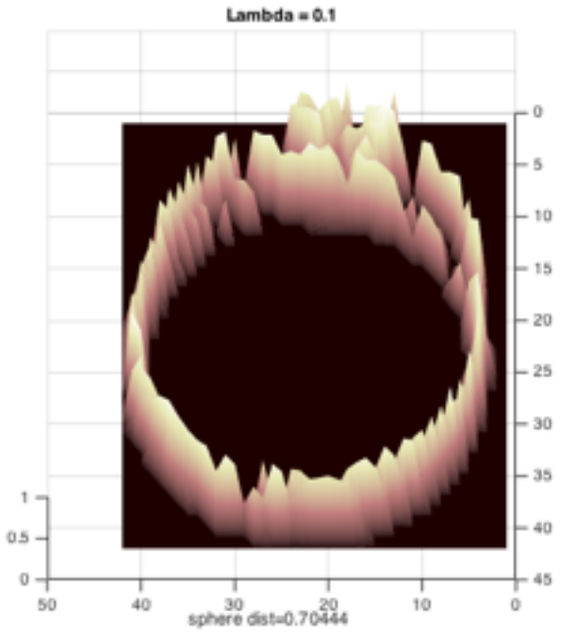
SHAPE L'ANE ROUGE

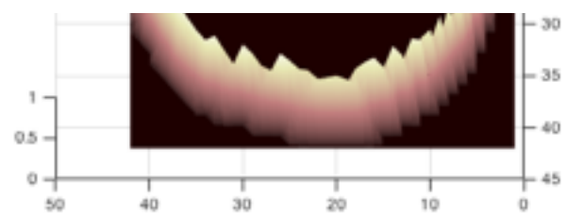
SAME SHAPE WARP

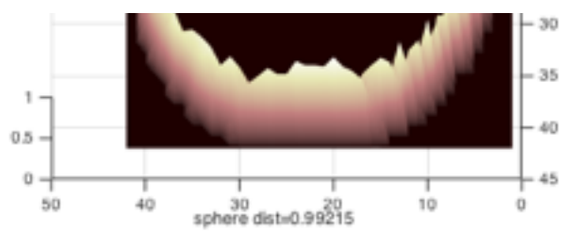








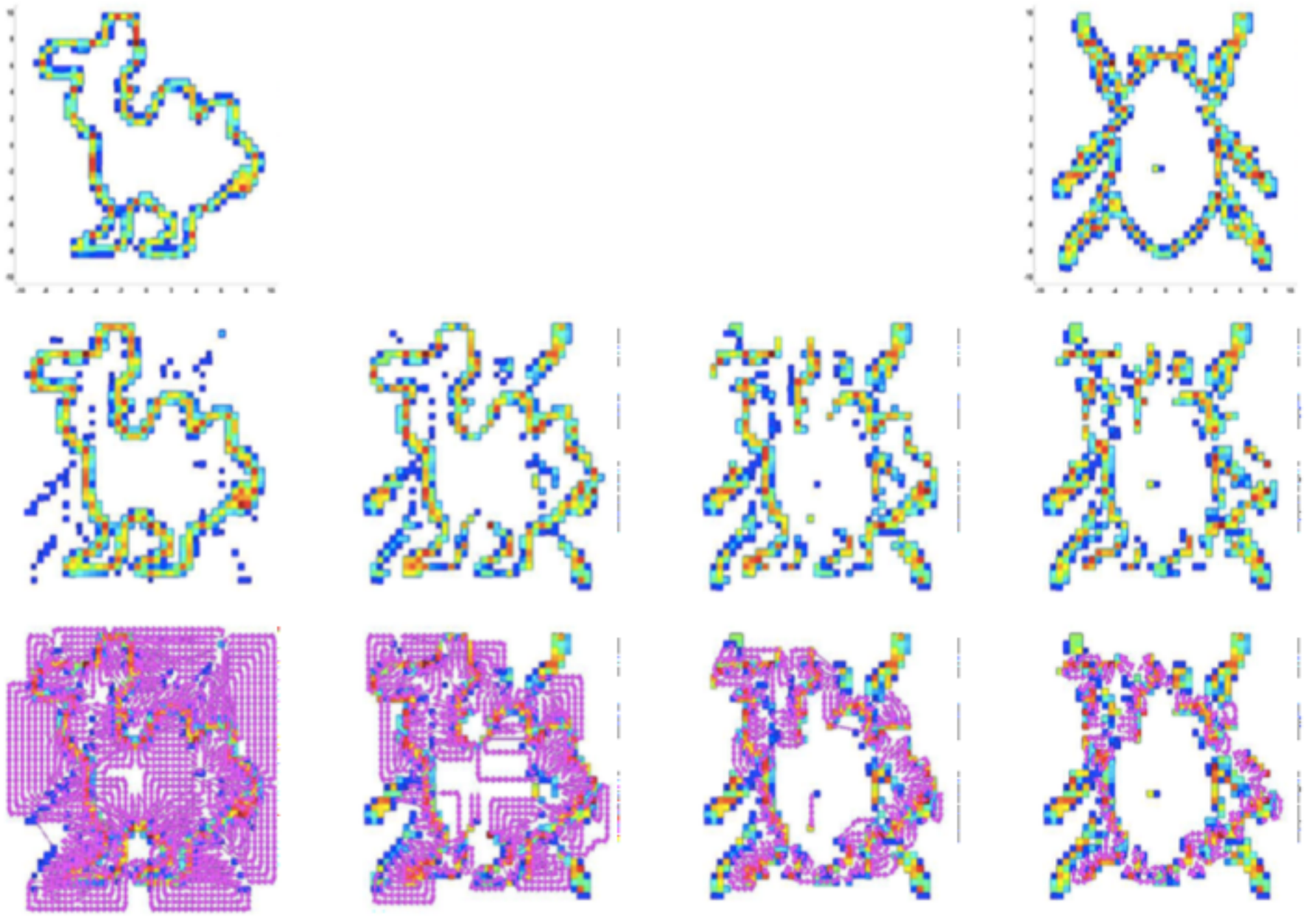




$\frac{1}{\lambda}$ ·····▶ MOVEMENT

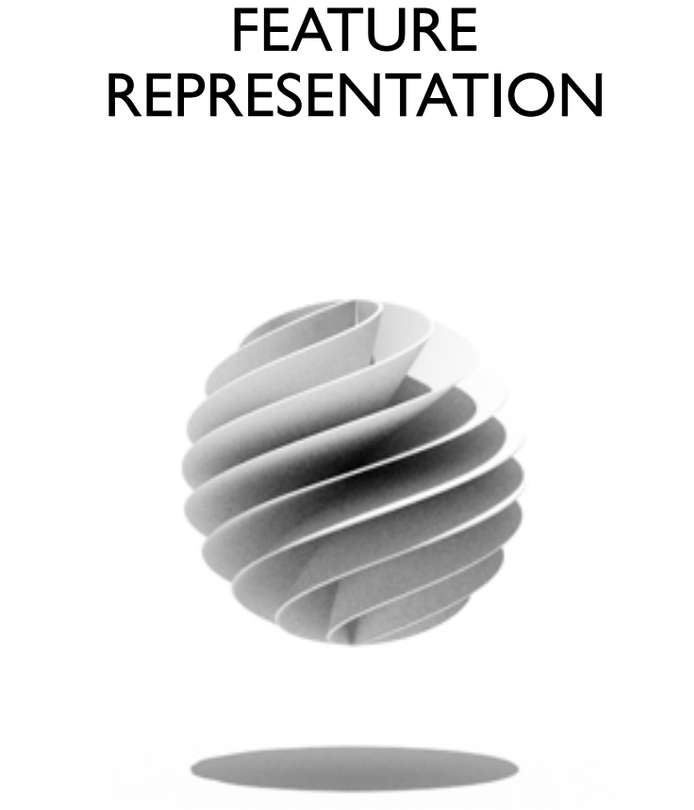
SHAPE L'ANE ROUGE

RESULTS ON DATASETS



FUTURE RESEARCH

- Optimization
  - Optimize multi-resolution
  - Extend to different dimensions
- Shape L'Ane Rouge
  - Optimize λ
  - Test on datasets
- Find better feature representations
- Investigate high-dimension visualization



THANK YOU