

# Simple Adaptive Mosaic Effects

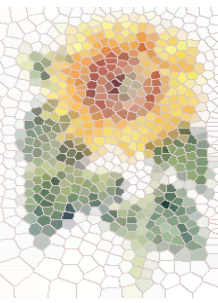
Geisa Martins Faustino  
Luiz Henrique de Figueiredo

IMPA

SIBGRAPI 2005



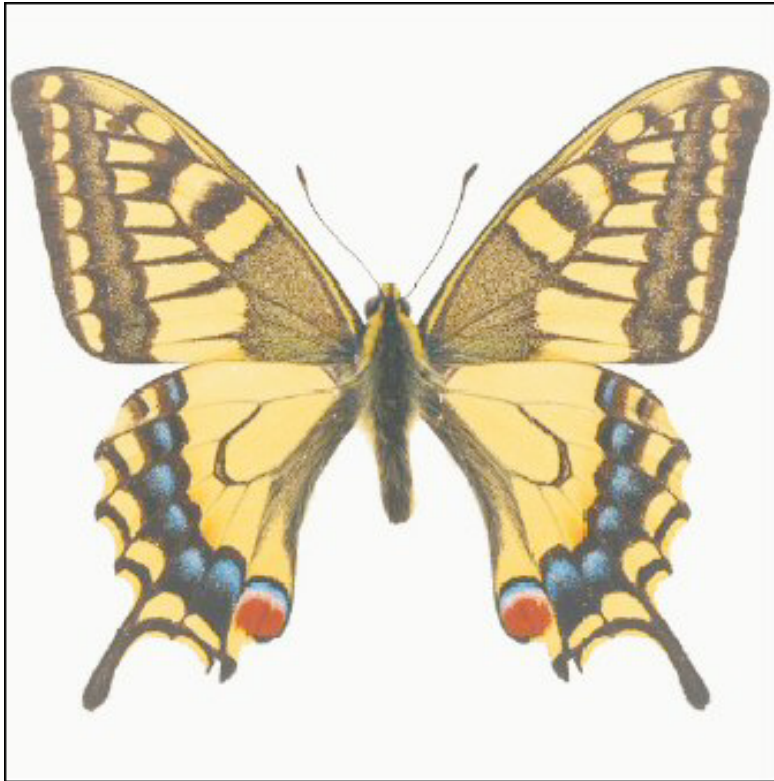
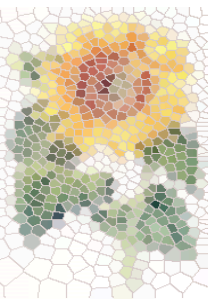
# Outline



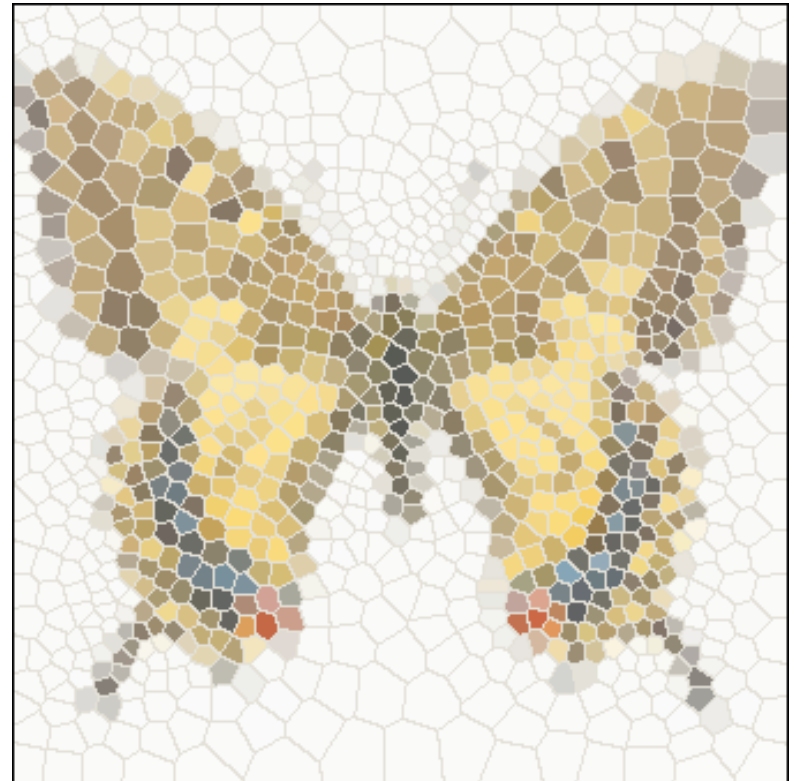
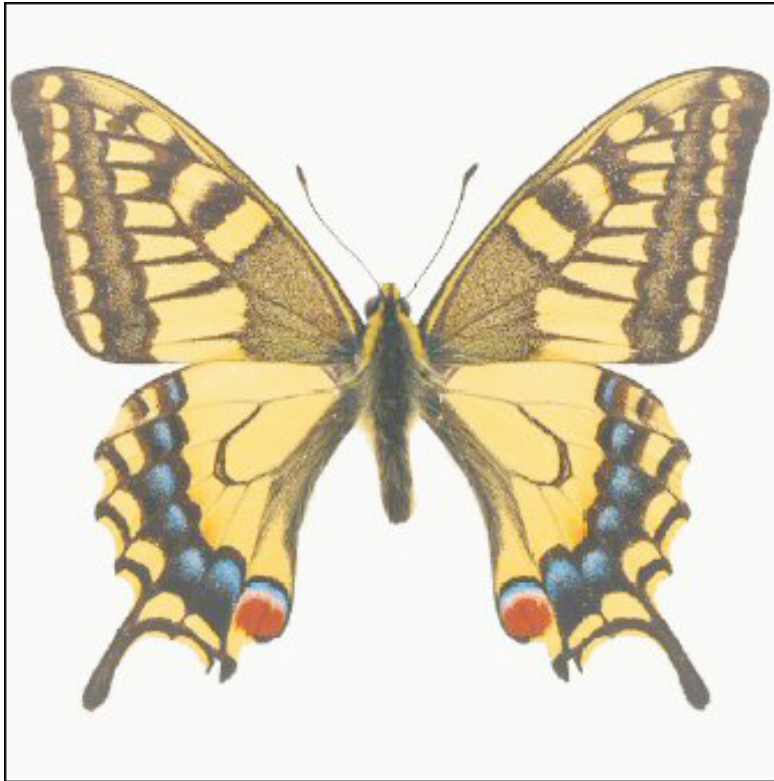
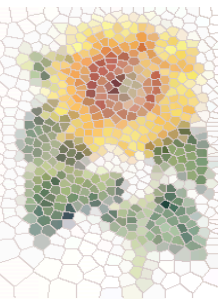
- The problem
- Related work
- Our algorithm
- Results
- Conclusions
- Future work

# The problem

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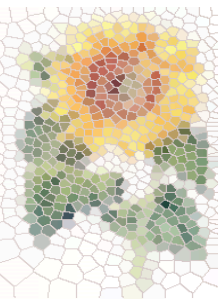
# The problem





# Related work

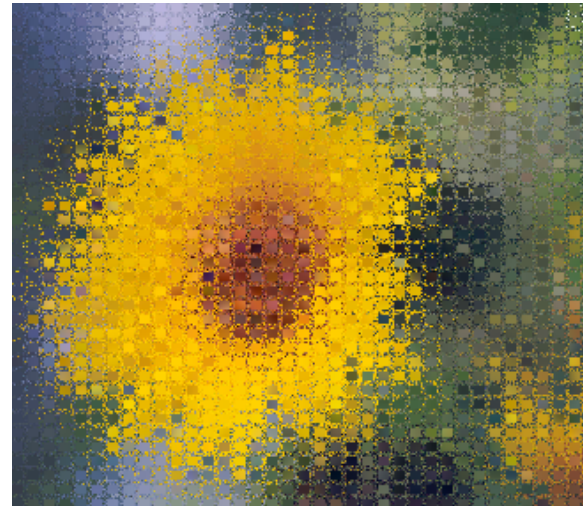
## image tools



Original  
Image



Paint Shop  
Pro



Adobe  
Photoshop



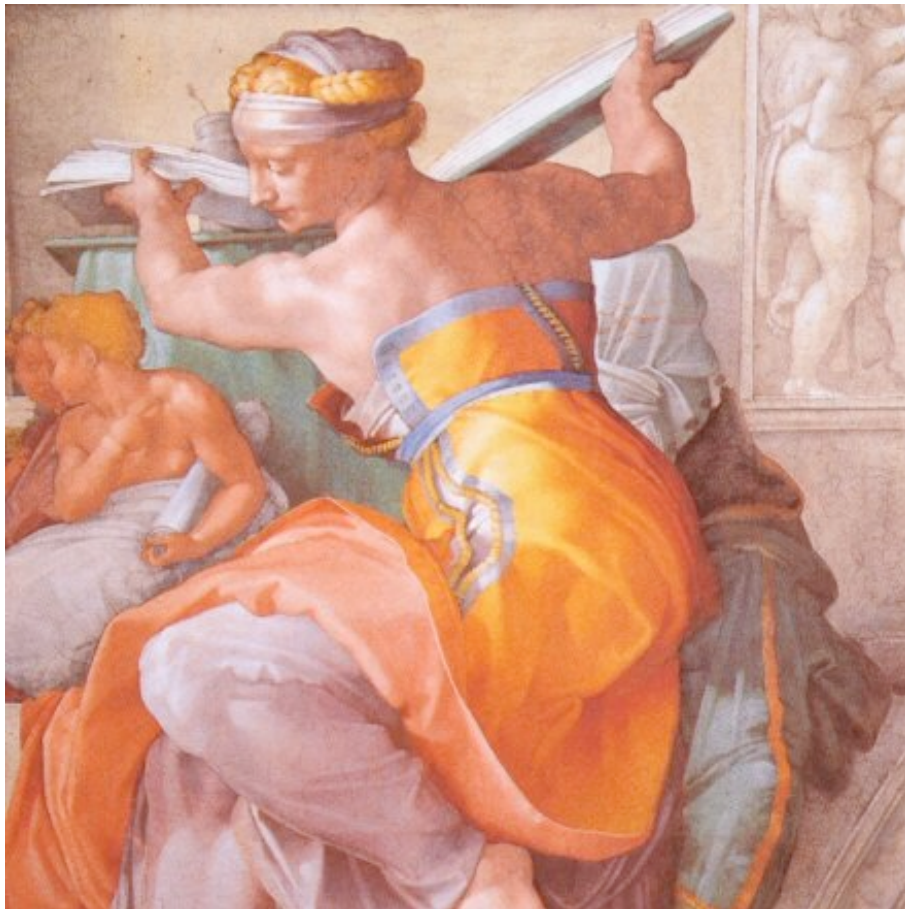
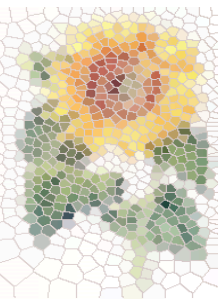
GIMP



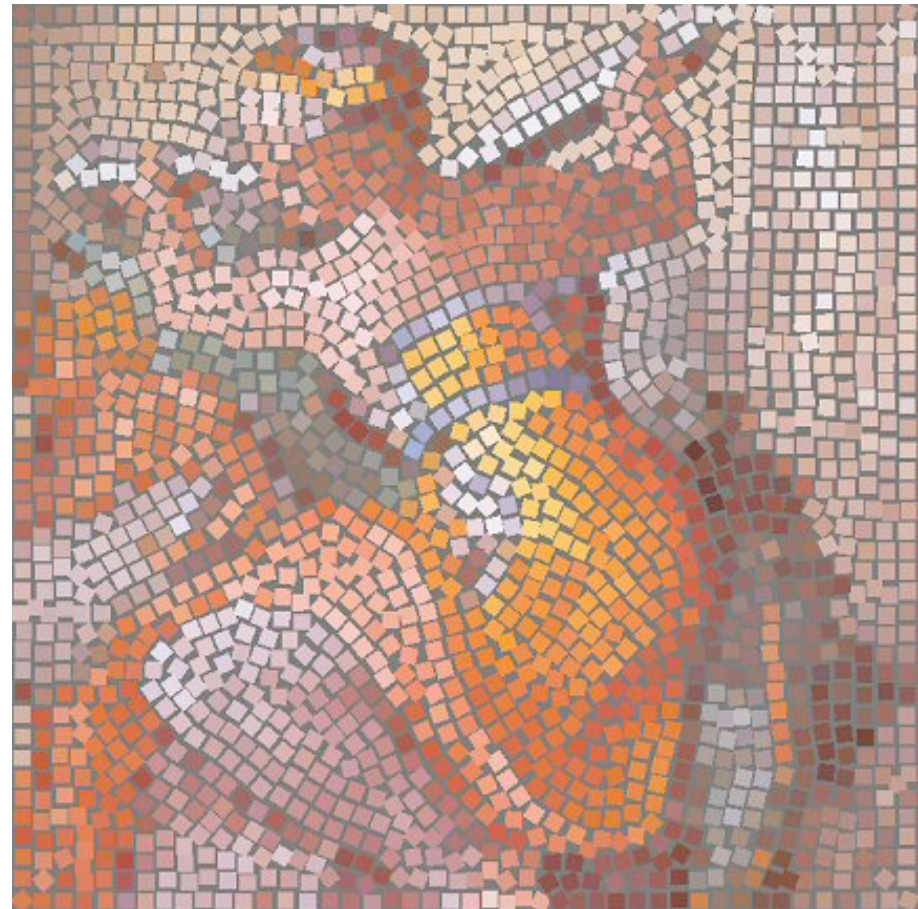


# Related work

## Hausner (SIGGRAPH 2001)



original image

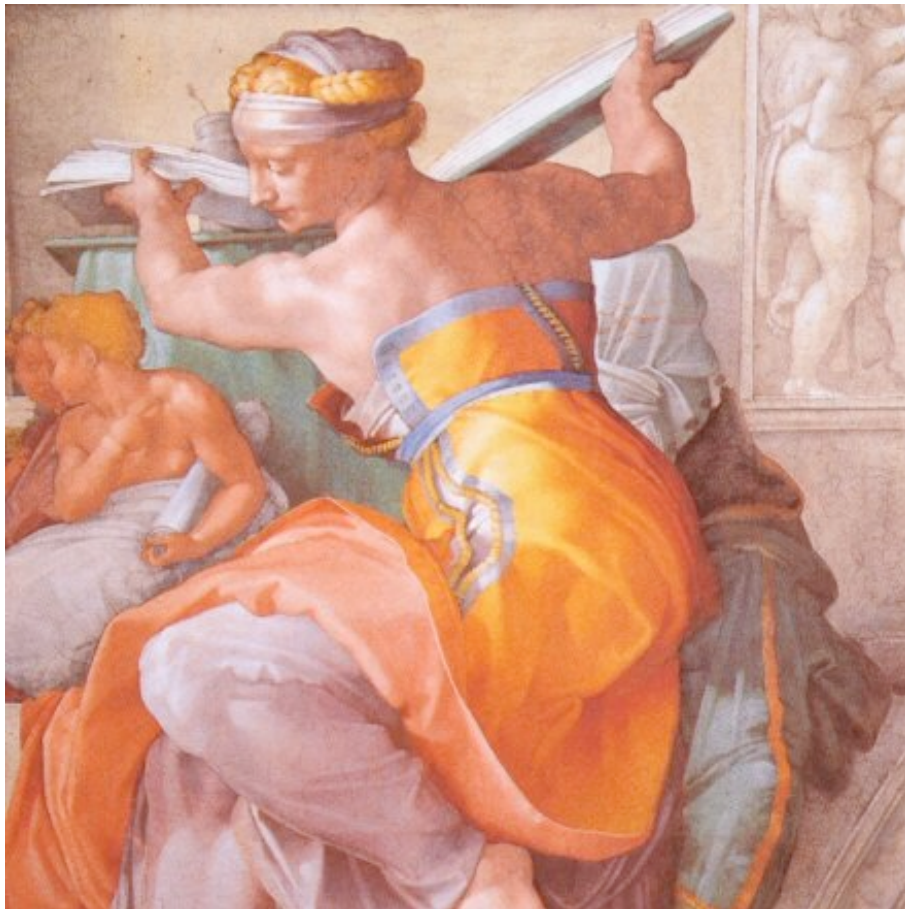
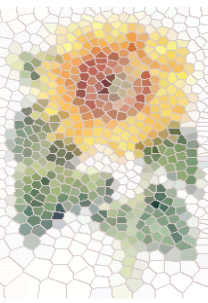


mosaic

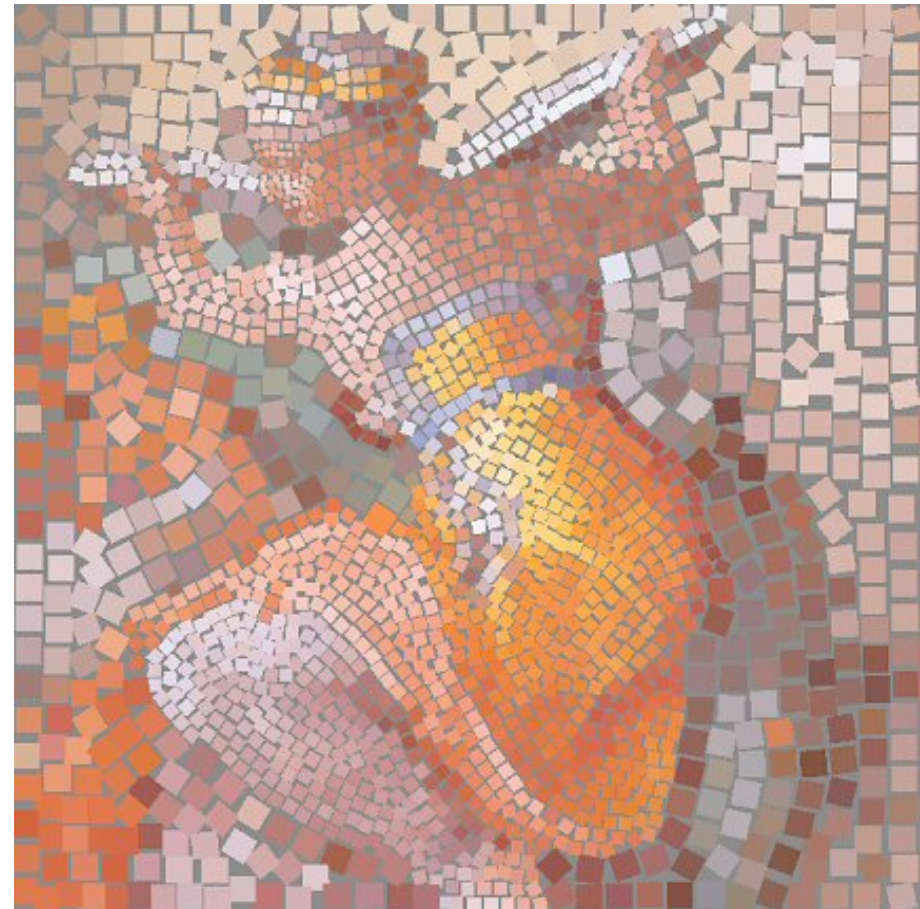


# Related work

## Hausner (SIGGRAPH 2001)



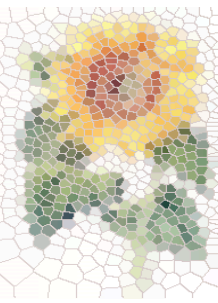
original image



mosaic

# Related work

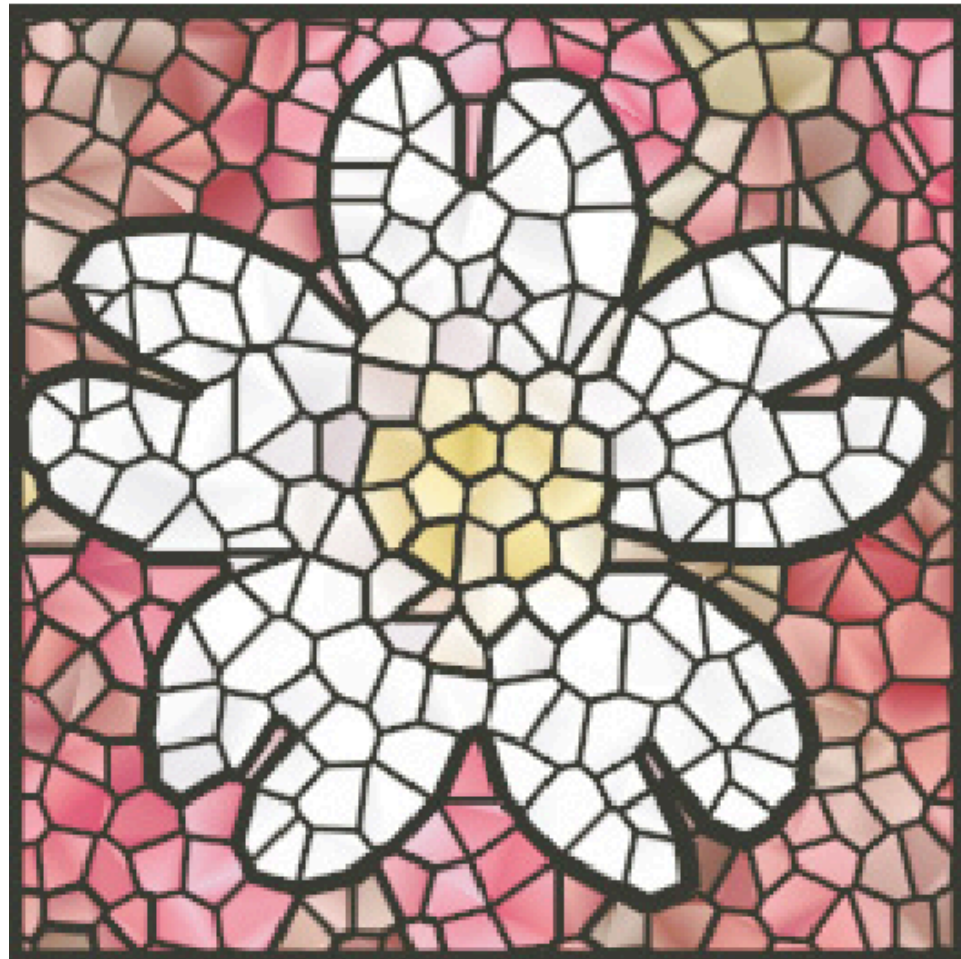
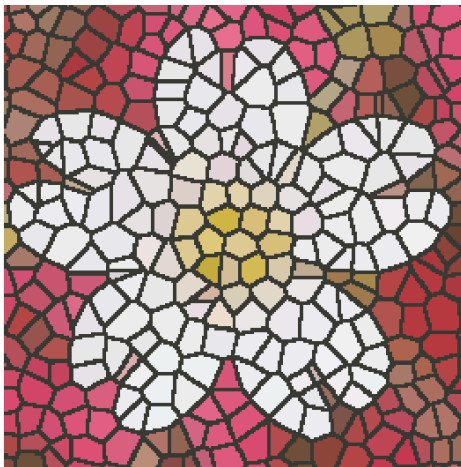
**Dobashi et al.** (EUROGRAPHICS 2002)



original  
image



mosaic

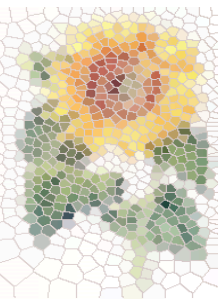


stained-  
glass  
effect



# Related work

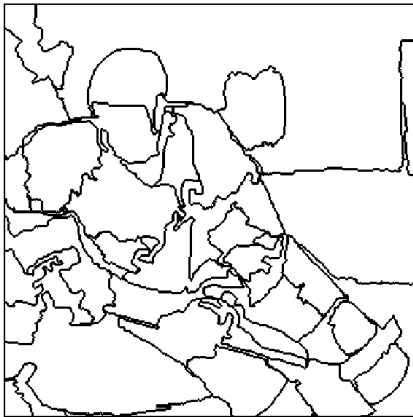
## Mould (EUROGRAPHICS 2003)



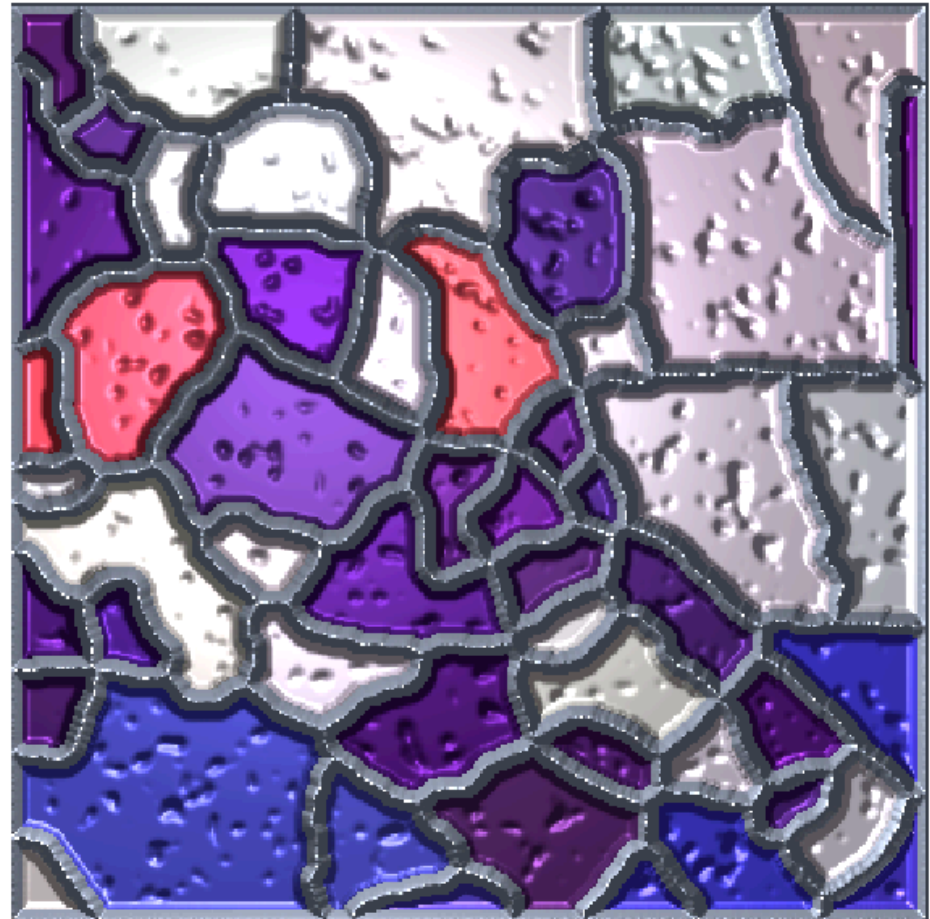
original image



segmented image



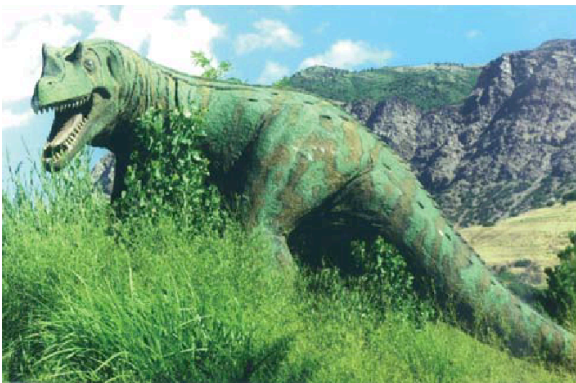
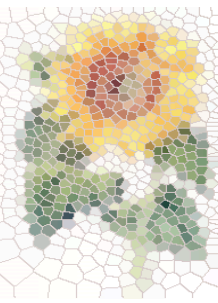
region outlines



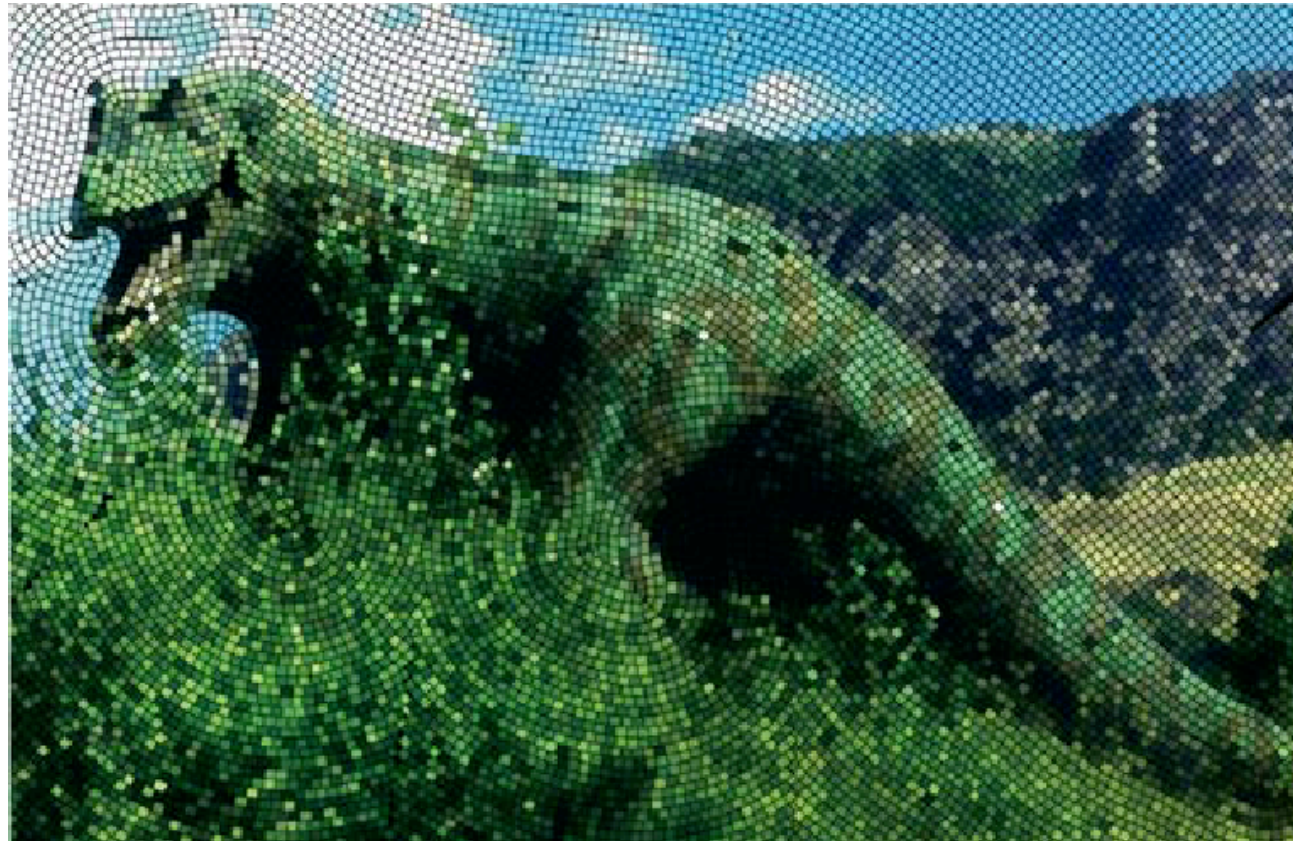
final image

# Related work

**Elber & Wolberg** (VISUAL COMPUTER 2003)



original image



final image



# Related work

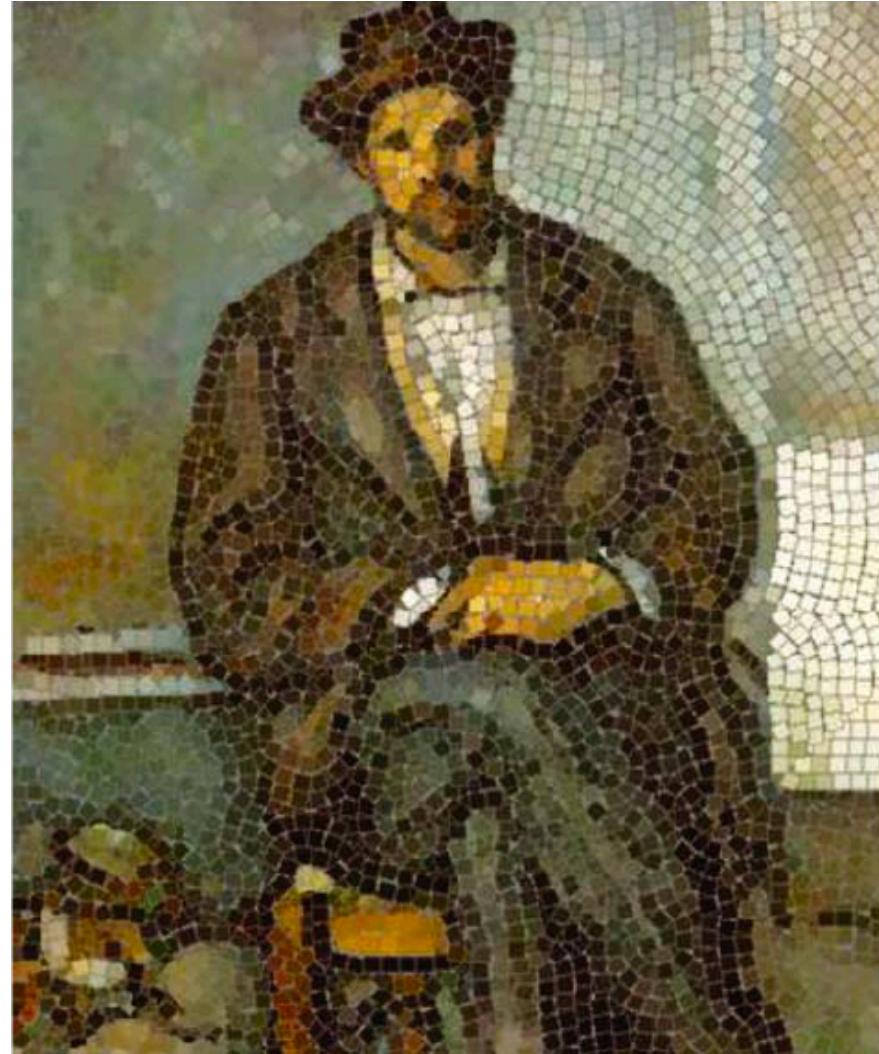
**Di Blasi & Gallo** (VISUAL COMPUTER 2005)



original image



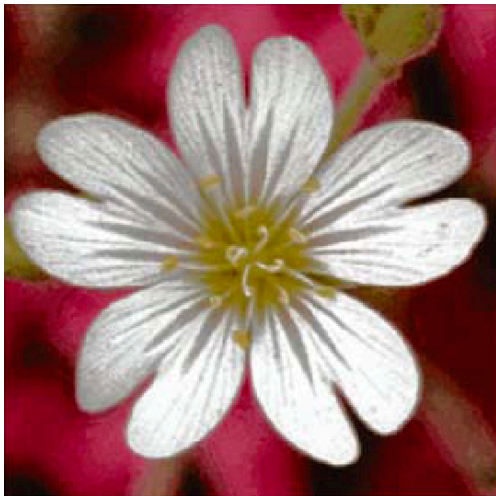
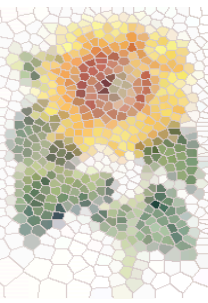
direction lines



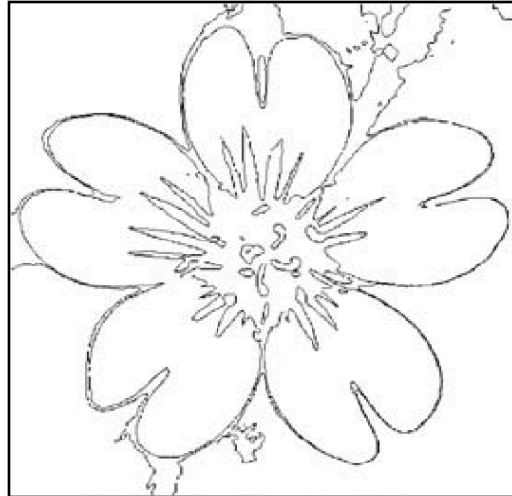
final image

# Related work

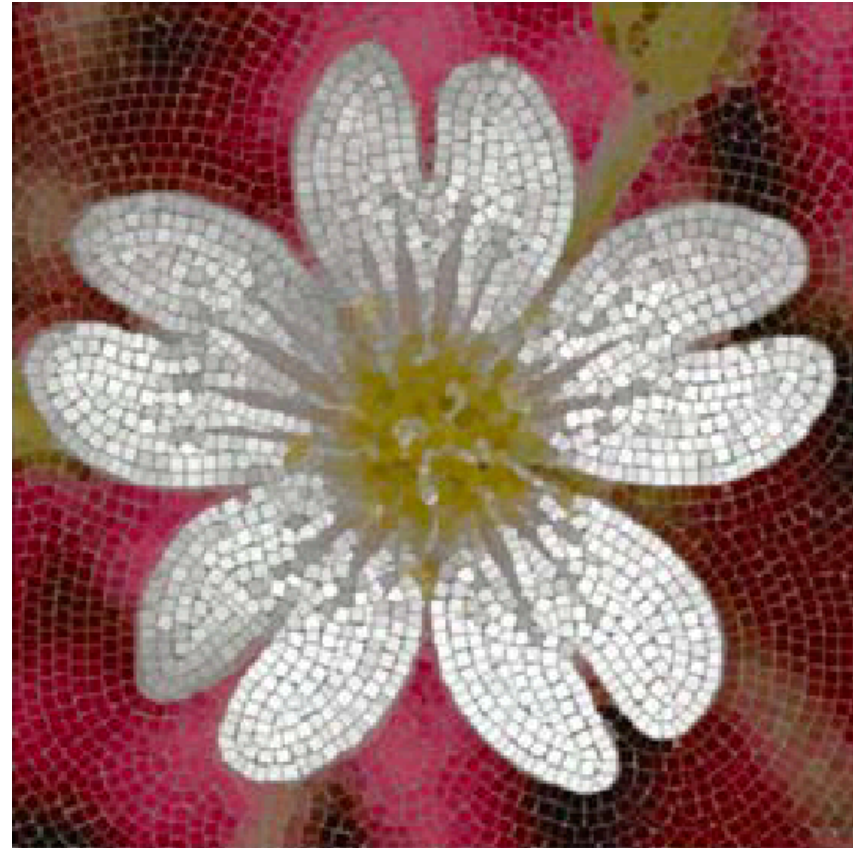
**Di Blasi & Gallo** (VISUAL COMPUTER 2005)



original image

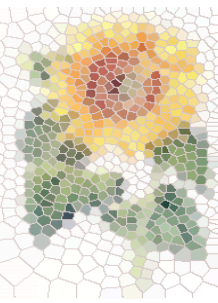


direction lines



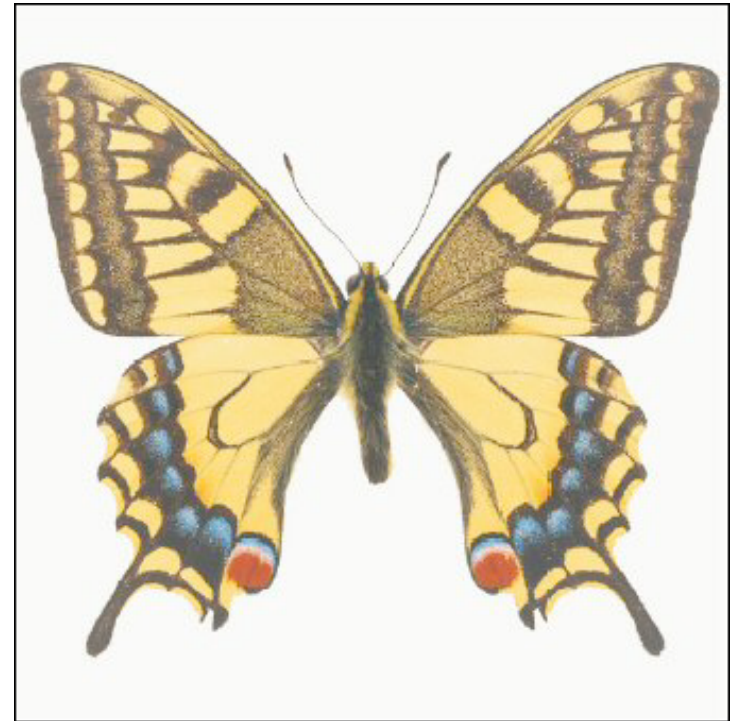
final image

# Our algorithm overview



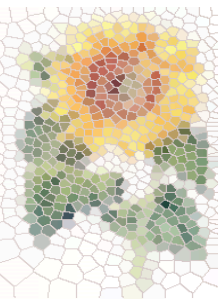
## Input is a digital image

1. Adaptive sampling of image finding seed points
2. Centroidal Voronoi diagram of seed points
3. Paint Voronoi regions
4. Paint Voronoi edges



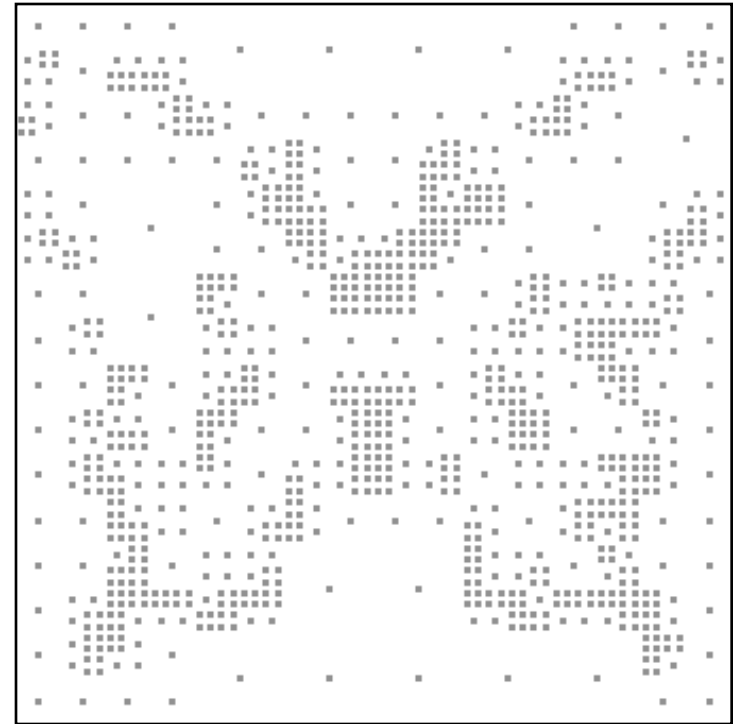


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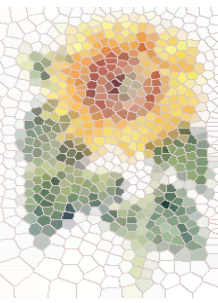


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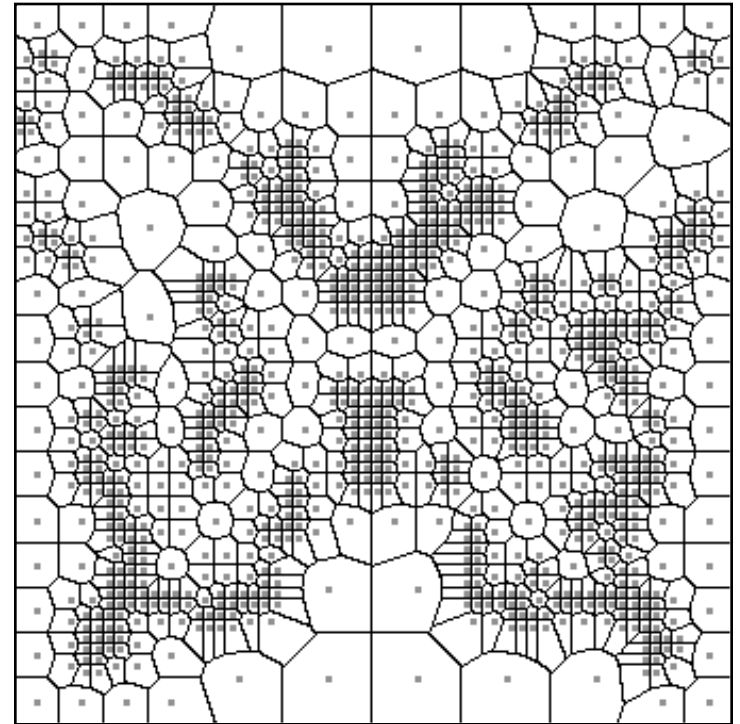


# Our algorithm overview

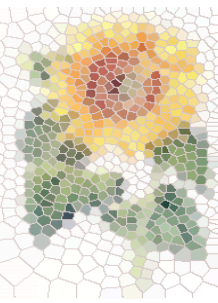


Input is a digital image

1. Adaptive sampling of image finding seed points
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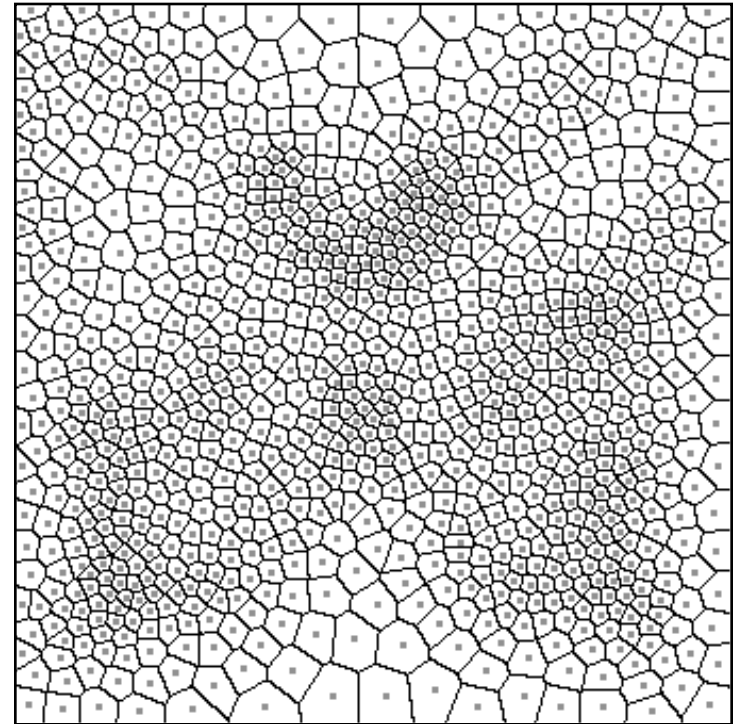


# Our algorithm overview



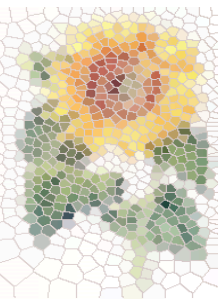
Input is a digital image

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3. Paint Voronoi regions
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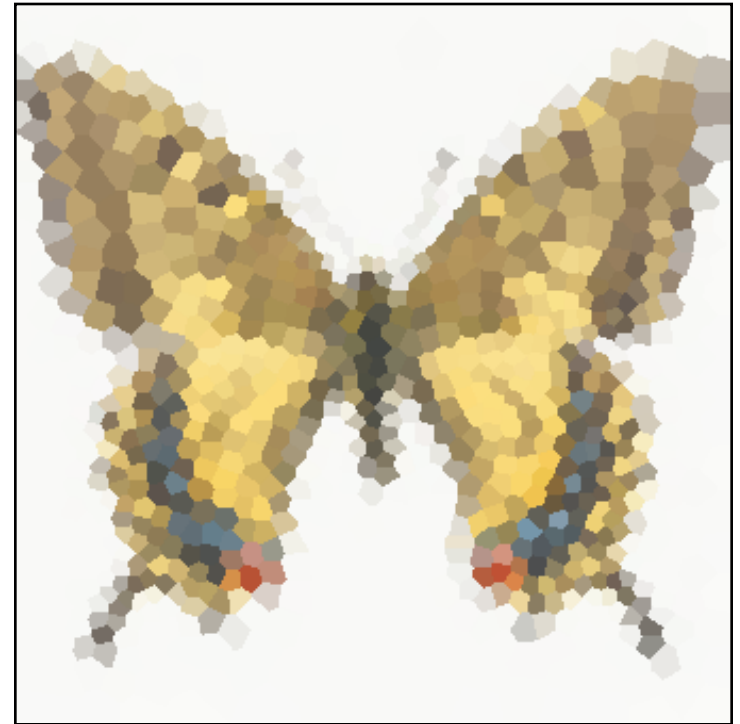


# Our algorithm overview

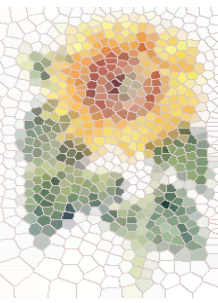


Input is a digital image

1. Adaptive sampling of image  
finding seed points
2. Find centroidal Voronoi diagram  
of seed points
- 3. Paint Voronoi regions**
4. Paint Voronoi edges

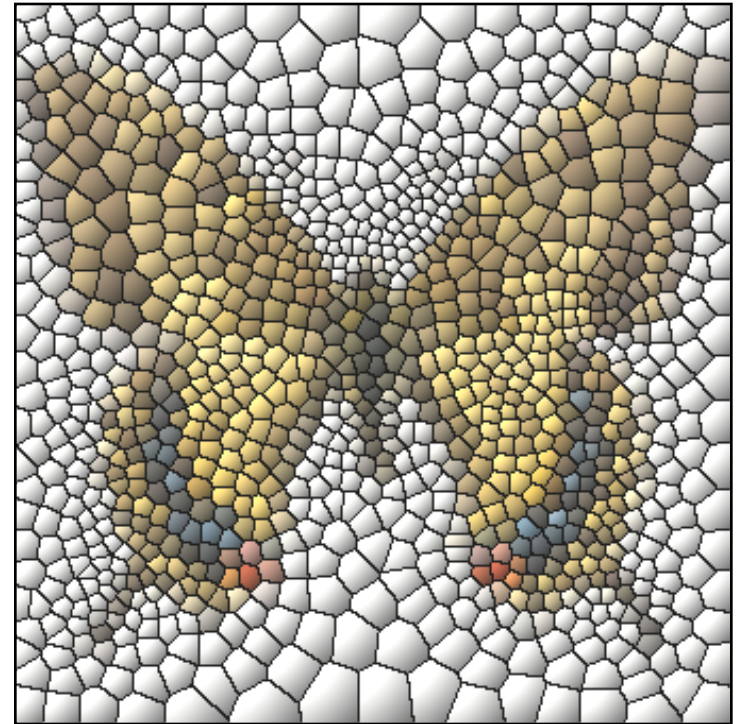


# Our algorithm overview

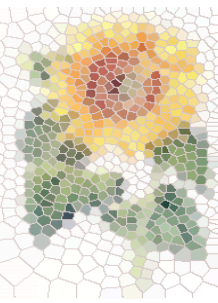


Input is a digital image

1. Adaptive sampling of image finding seed points
2. Find centroidal Voronoi diagram of seed points
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# Sampling the image



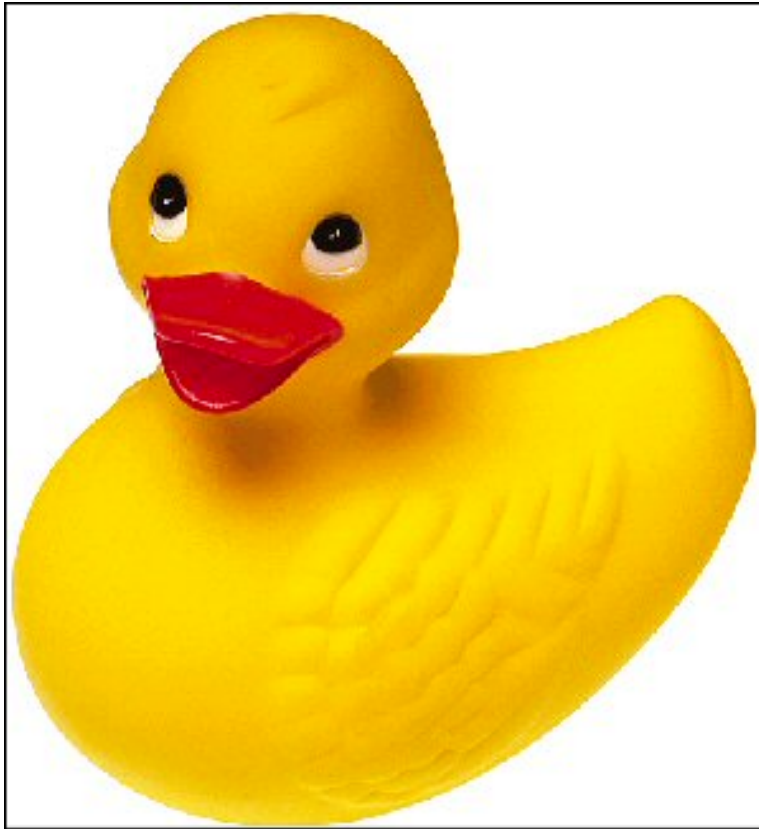
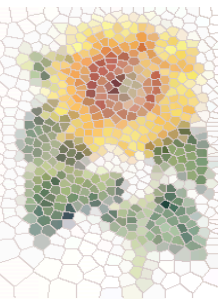
$$C_M = \frac{1}{A_R} \sum_{p \in R} I(p)$$

**Average color in R**

$$E_{\text{cor}} = \max_{p \in R} d(I(p), C_M)^2$$



# Sampling the image



$$C_M = \frac{1}{A_R} \sum_{p \in R} I(p)$$

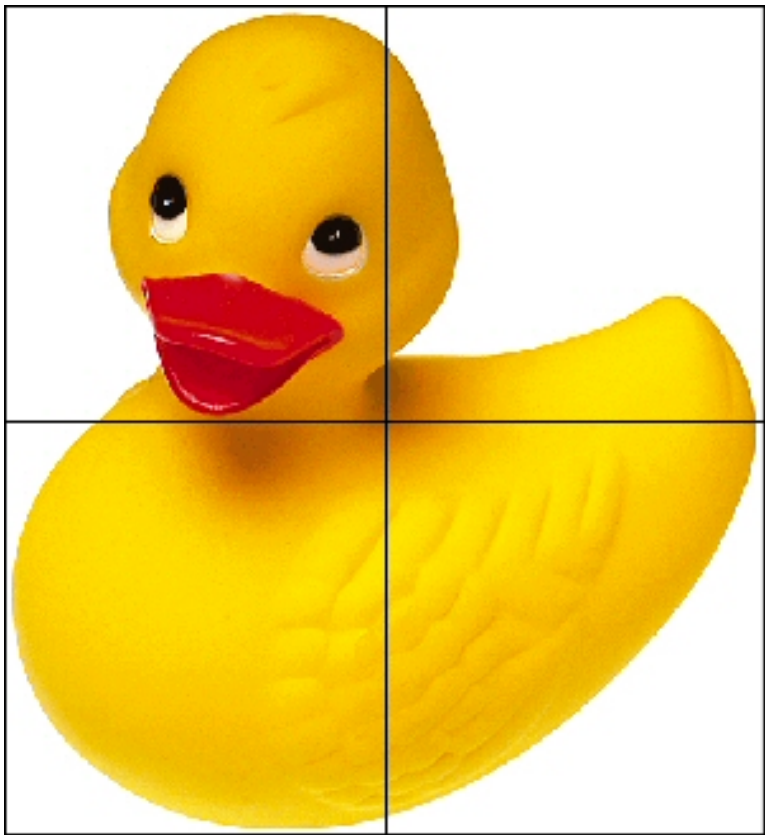
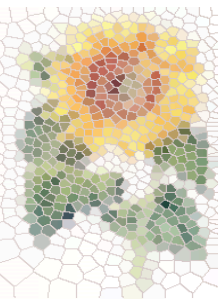
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$$E_{\text{cor}} < \epsilon \quad \text{or} \quad A_R < L$$

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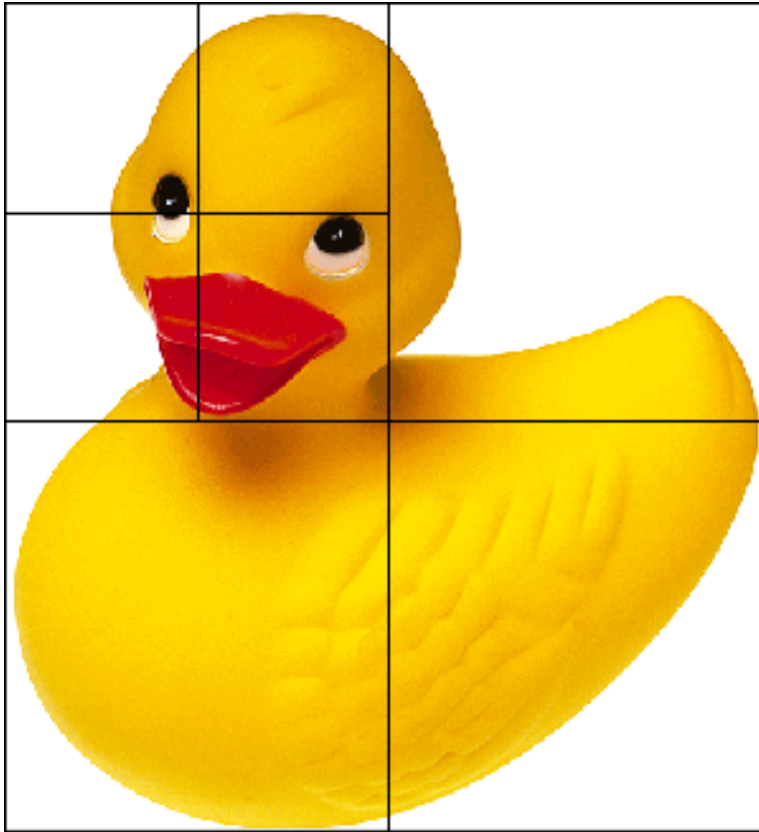
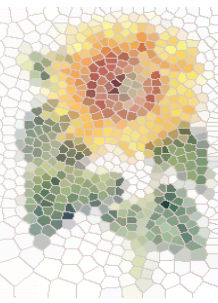
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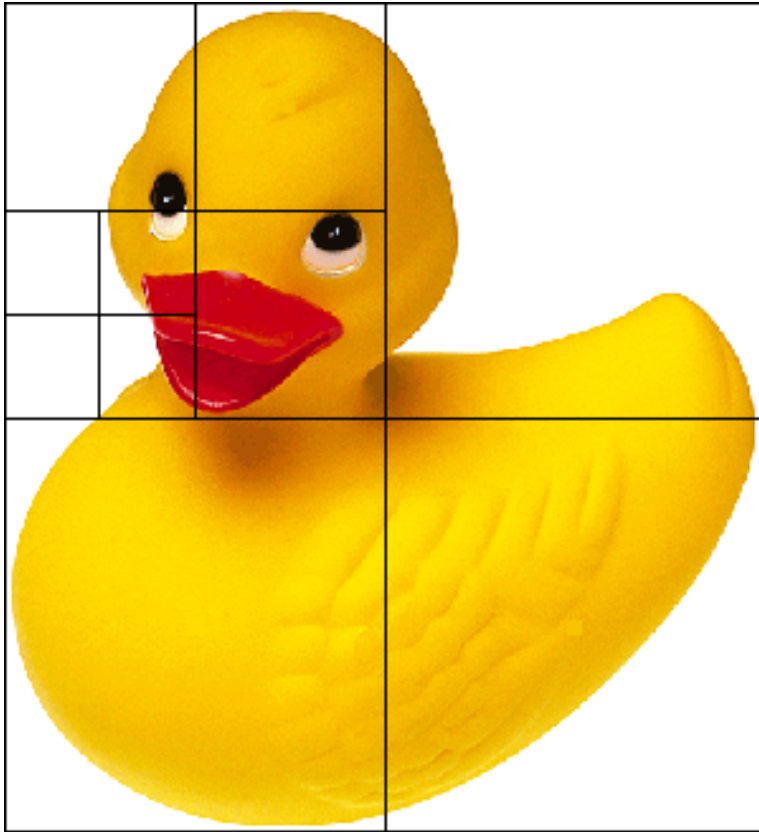
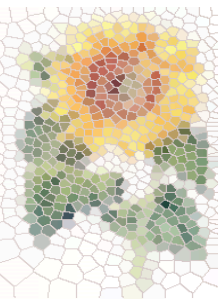
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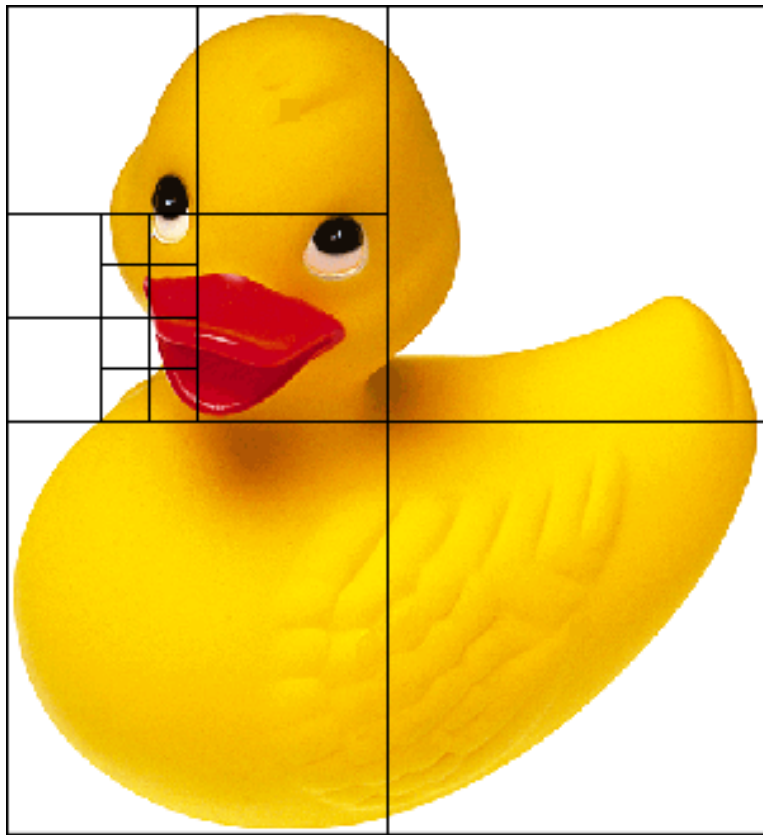
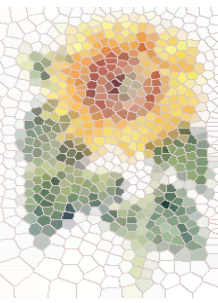
**Average color in R**

$$E_{\text{cor}} = \max_{p \in R} d(I(p), C_M)^2$$



$$E_{\text{cor}} < \epsilon \quad \text{or} \quad A_R < L$$

# Sampling the image



$$C_M = \frac{1}{A_R} \sum_{p \in R} I(p)$$

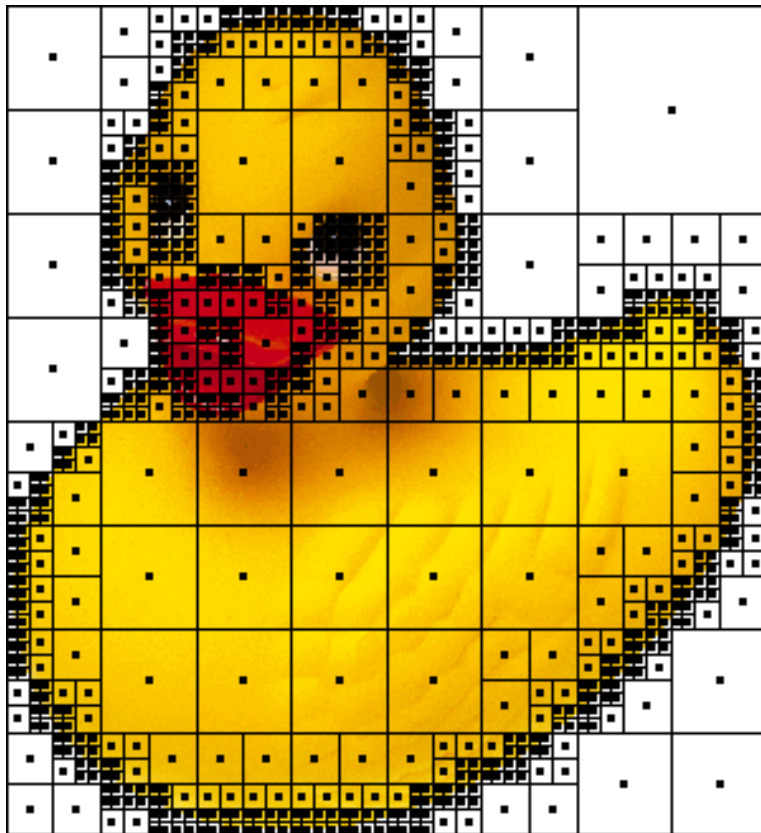
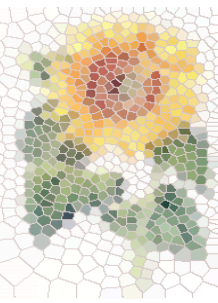
**Average color in R**

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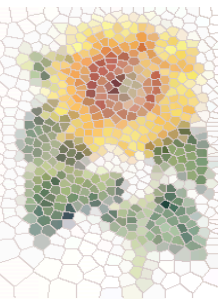
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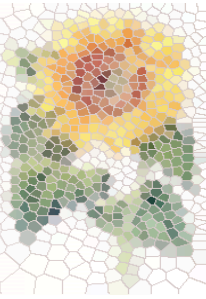


$$E_{\text{cor}} < \epsilon \quad \text{or} \quad A_R < L$$

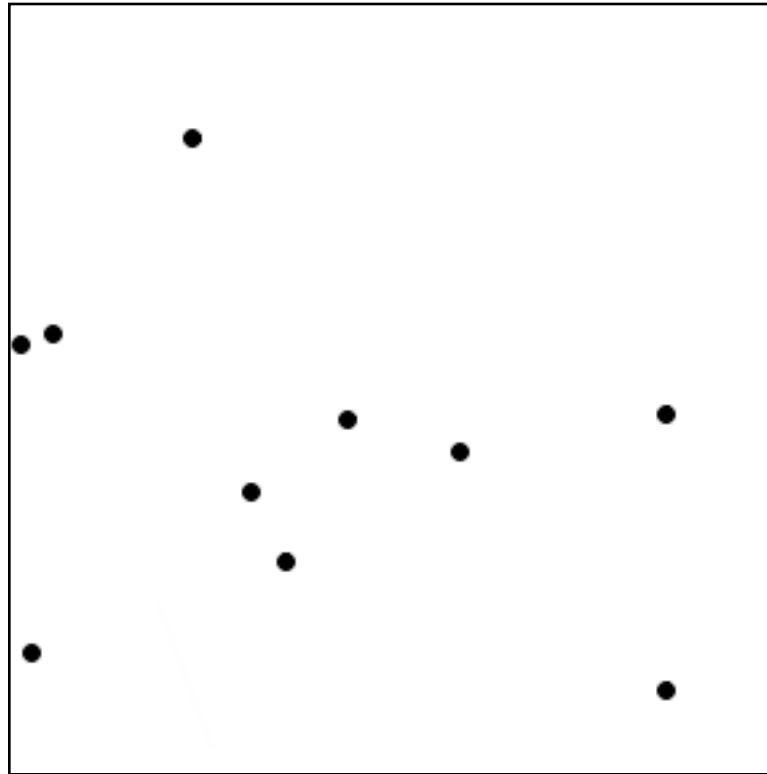
# Sampling the image



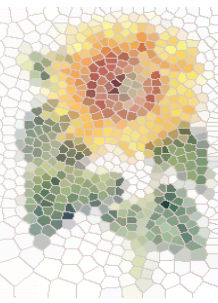
# Centroidal Voronoi diagrams



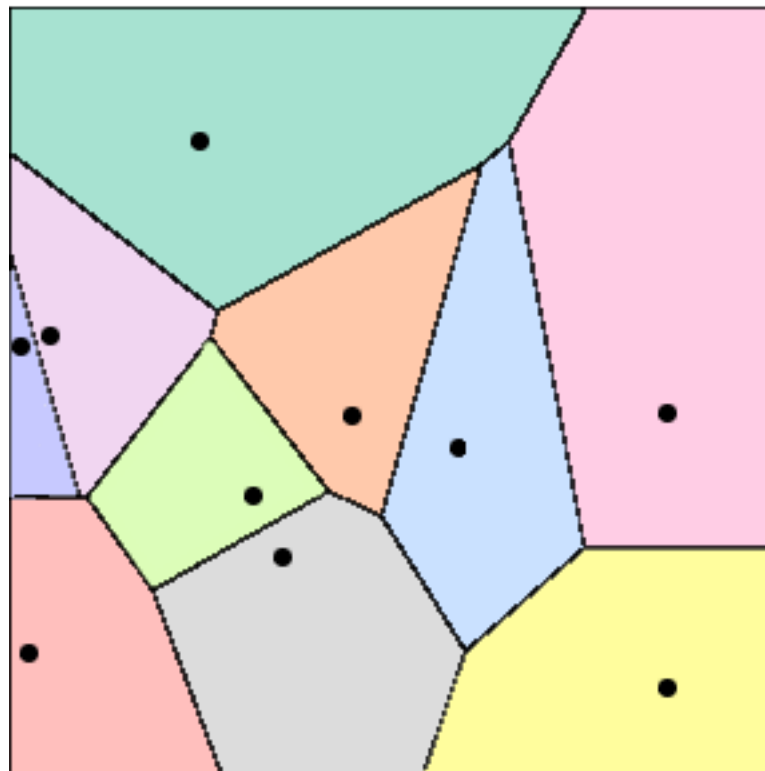
sites



# Centroidal Voronoi diagrams

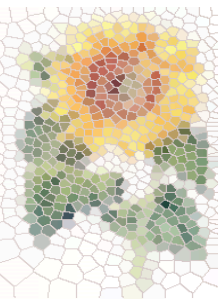


Voronoi  
diagram

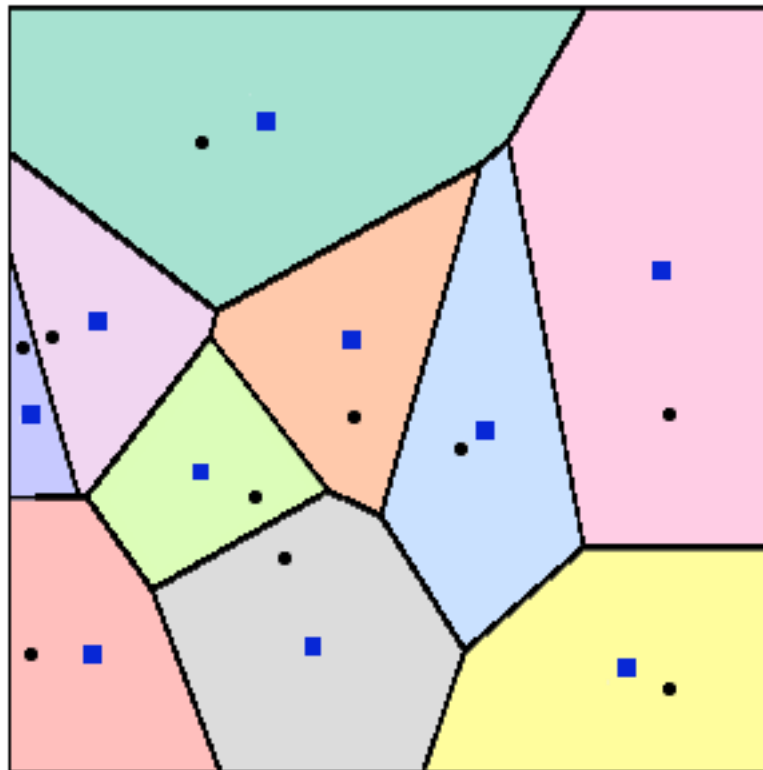




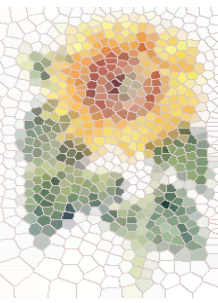
# Centroidal Voronoi diagrams



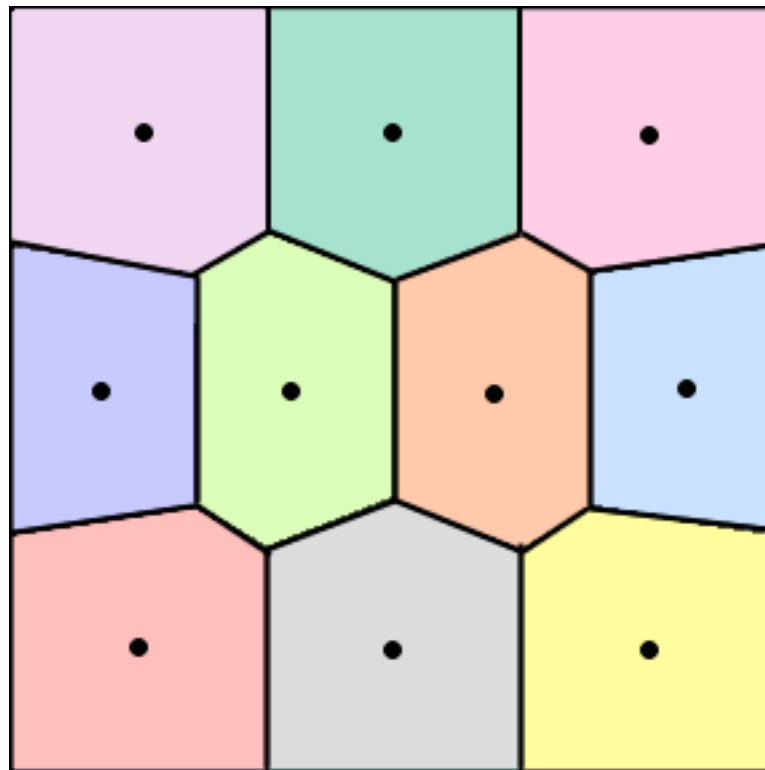
Lloyd  
relaxation



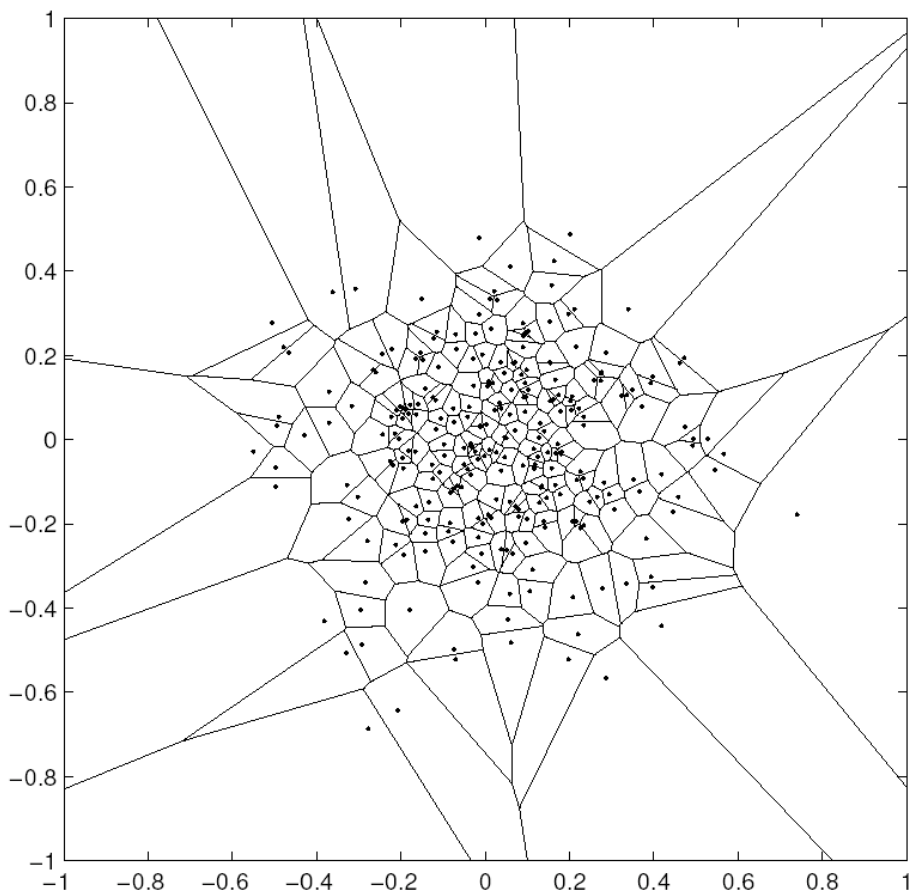
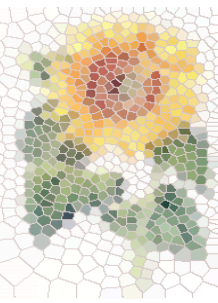
# Centroidal Voronoi diagrams



Centroidal  
Voronoi  
diagram



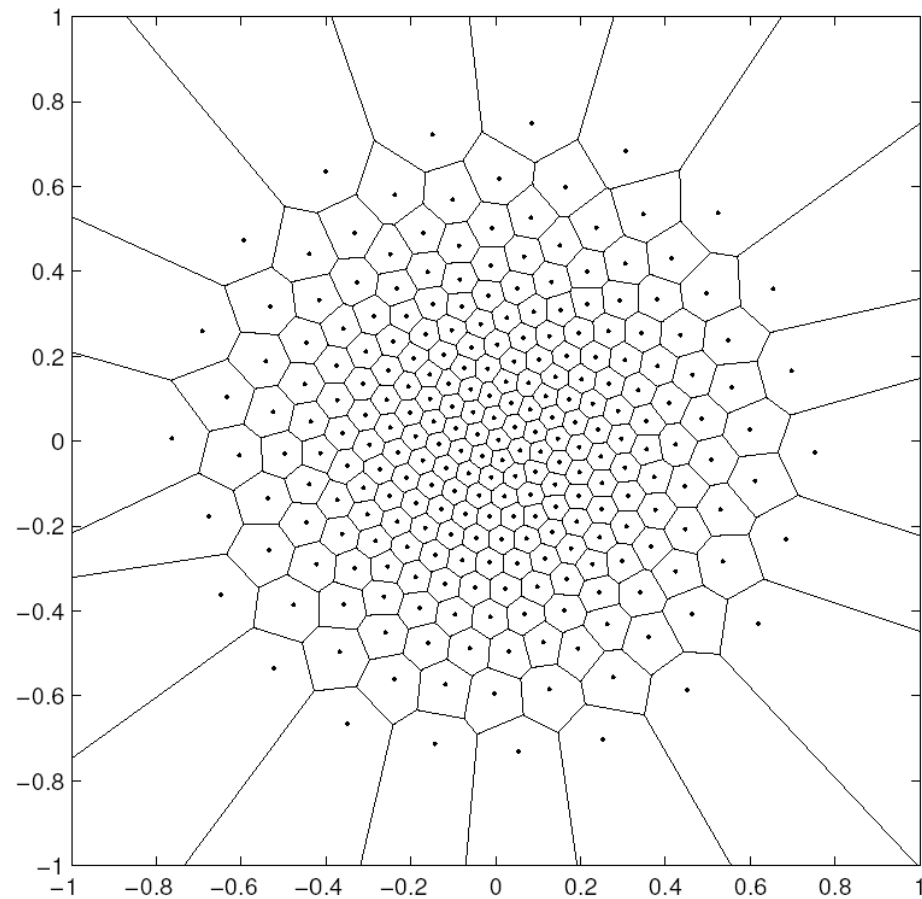
# Centroidal Voronoi diagrams



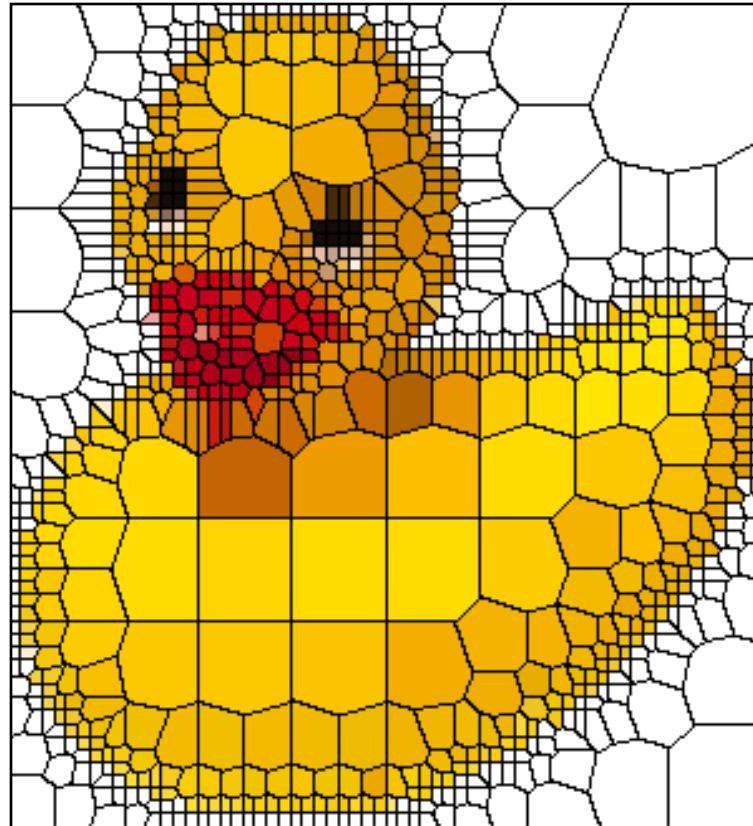
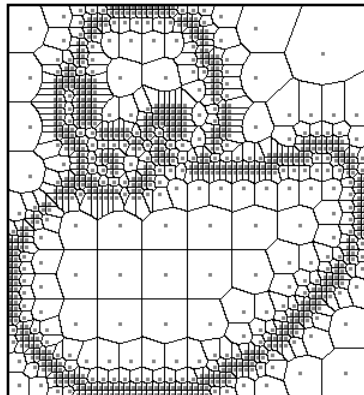
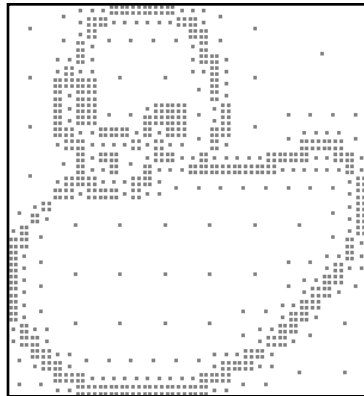
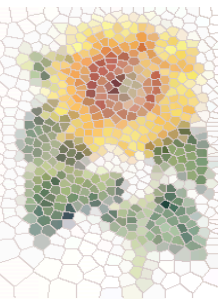
density function

$$e^{-10x^2 - 10y^2}$$

in  $[-1, 1]^2$

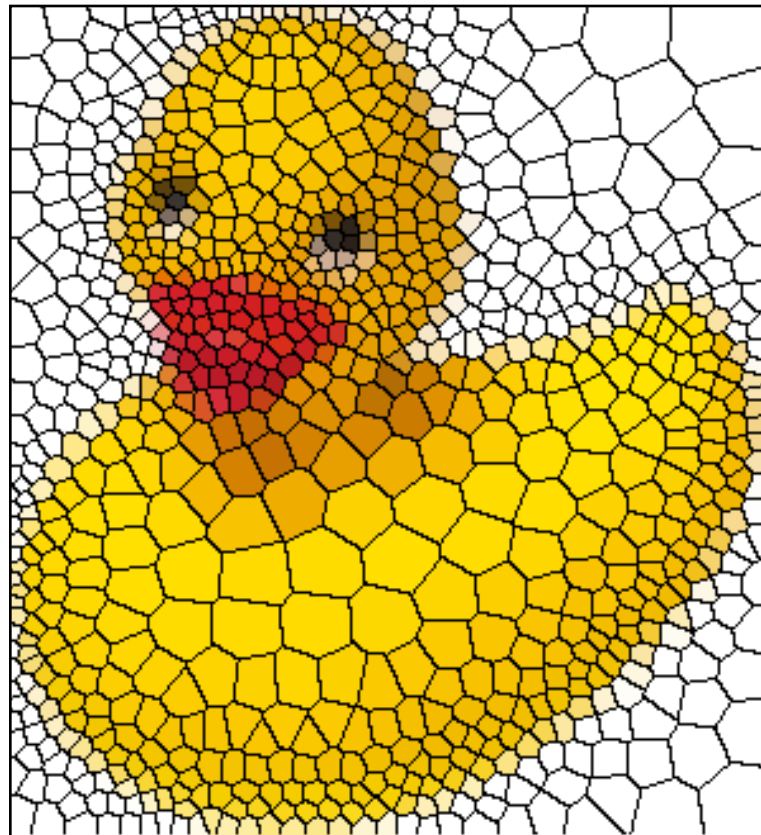
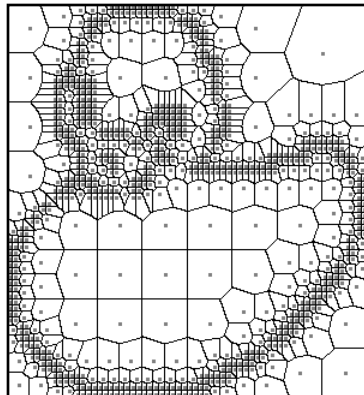
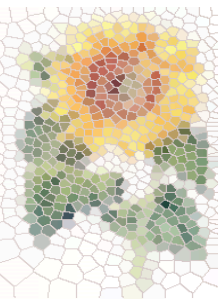


# Why centroidal Voronoi diagrams?

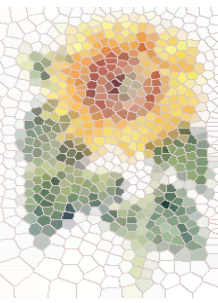




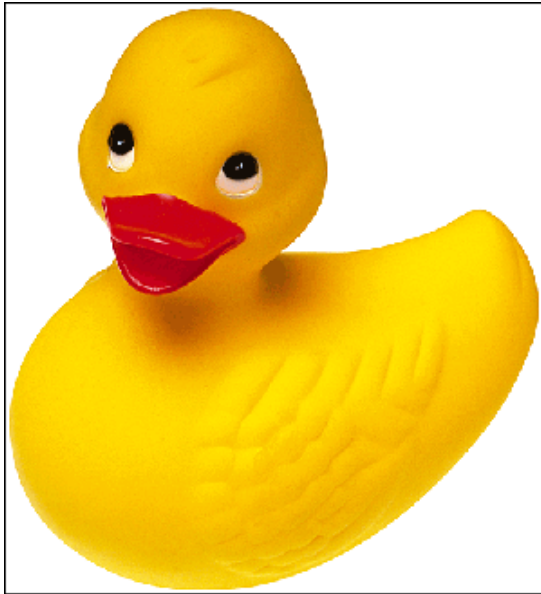
# Why centroidal Voronoi diagrams?



# Centroidal Voronoi diagrams



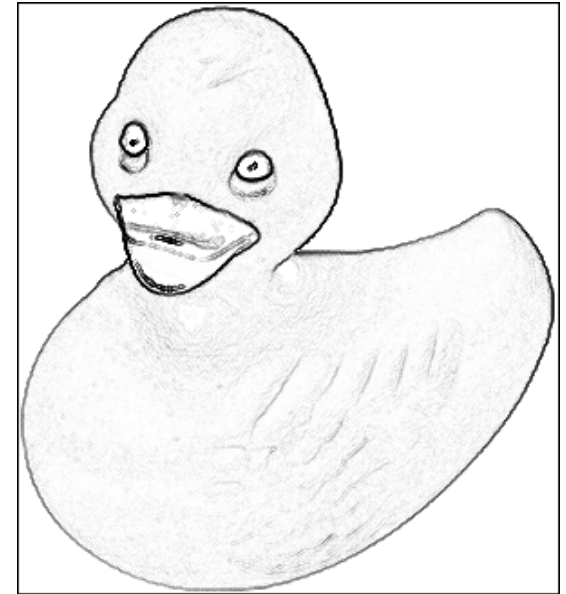
Density function is Euclidean norm of gradient of luminance



original image

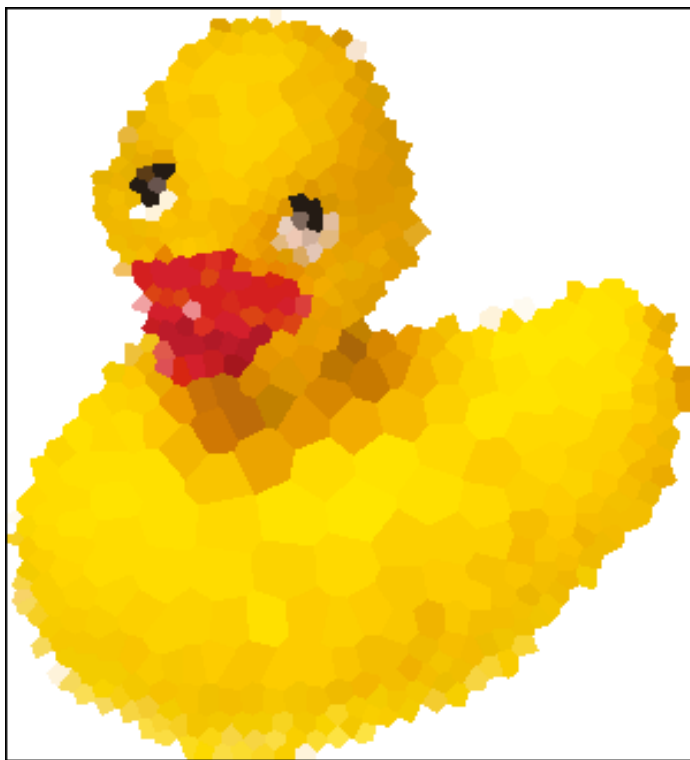
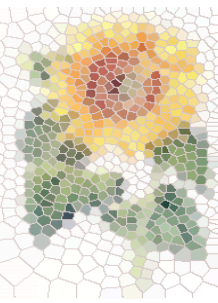


luminance

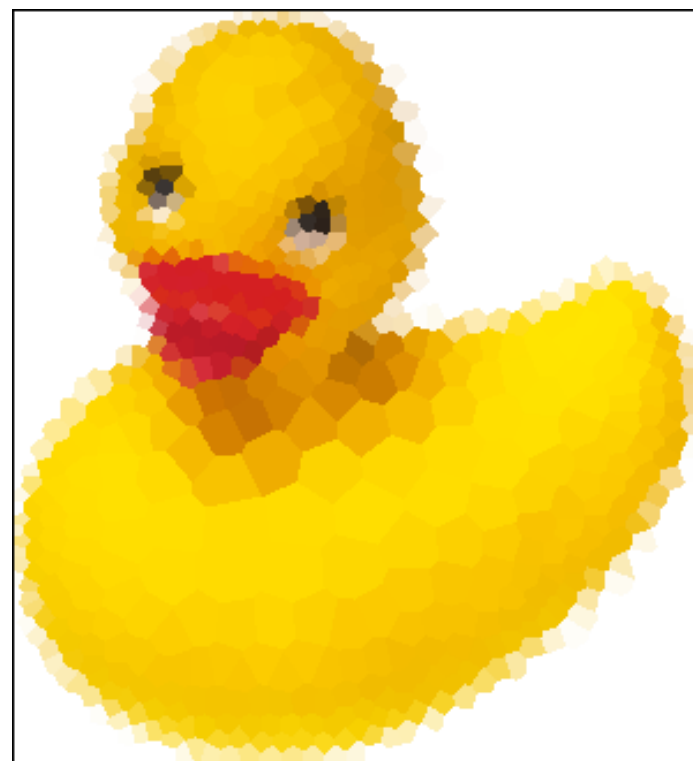


density

# Paint Voronoi cells

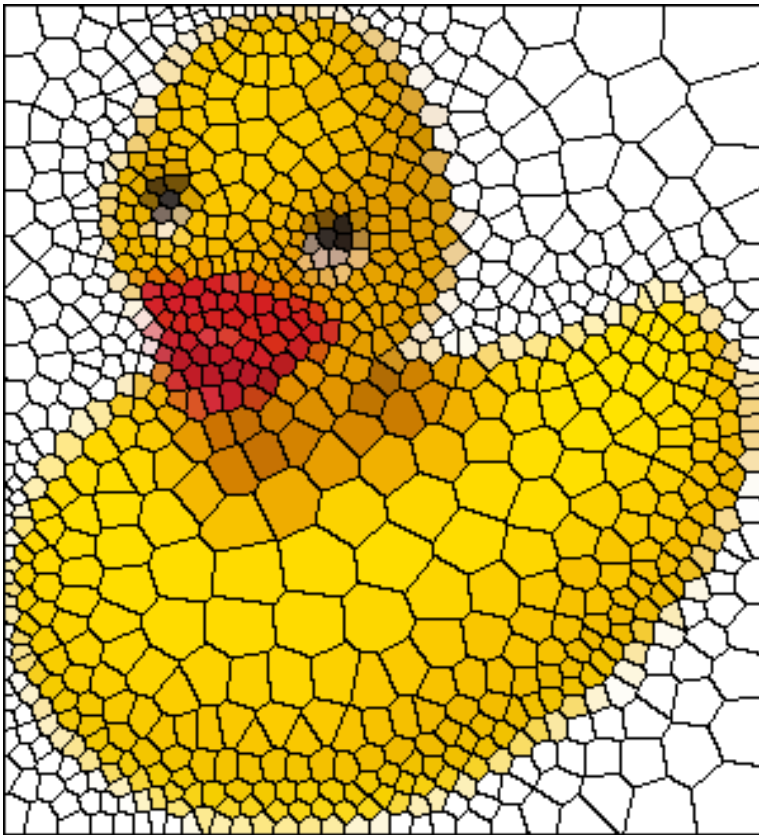
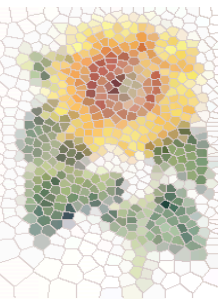


center color

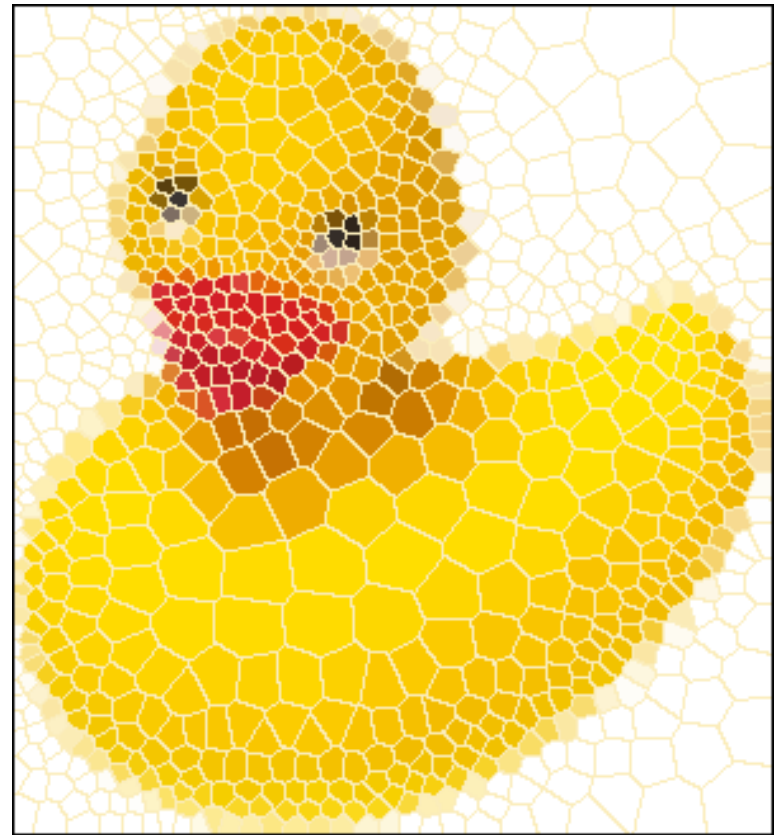


average color

# Paint Voronoi edges



black – stained-glass

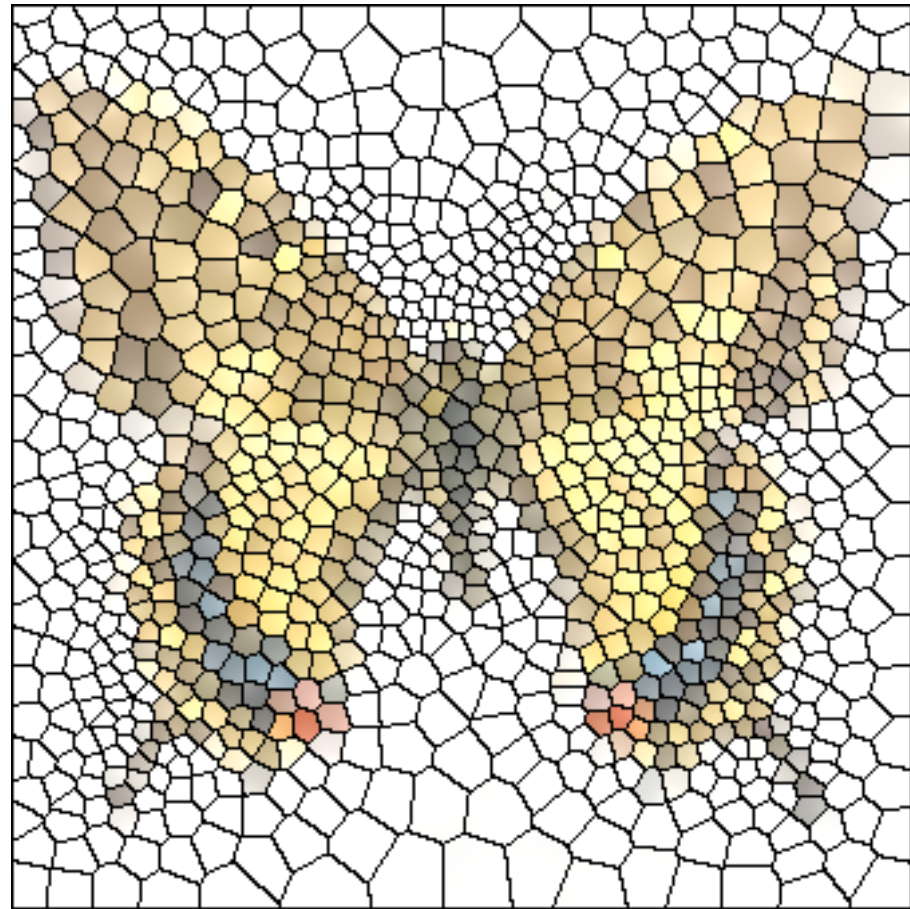
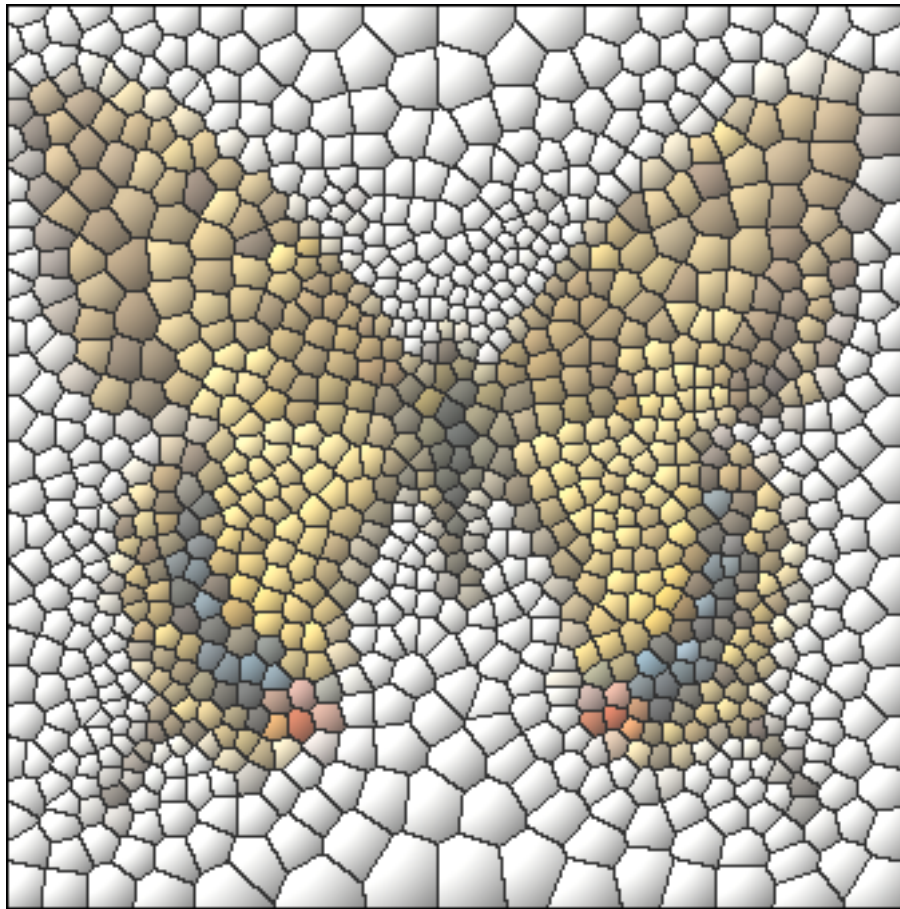
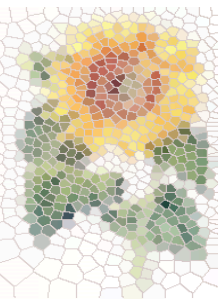


background – mosaic



# Visual effects synthetic illumination

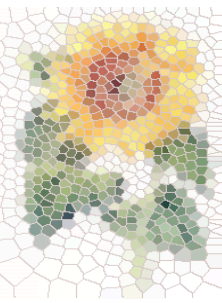
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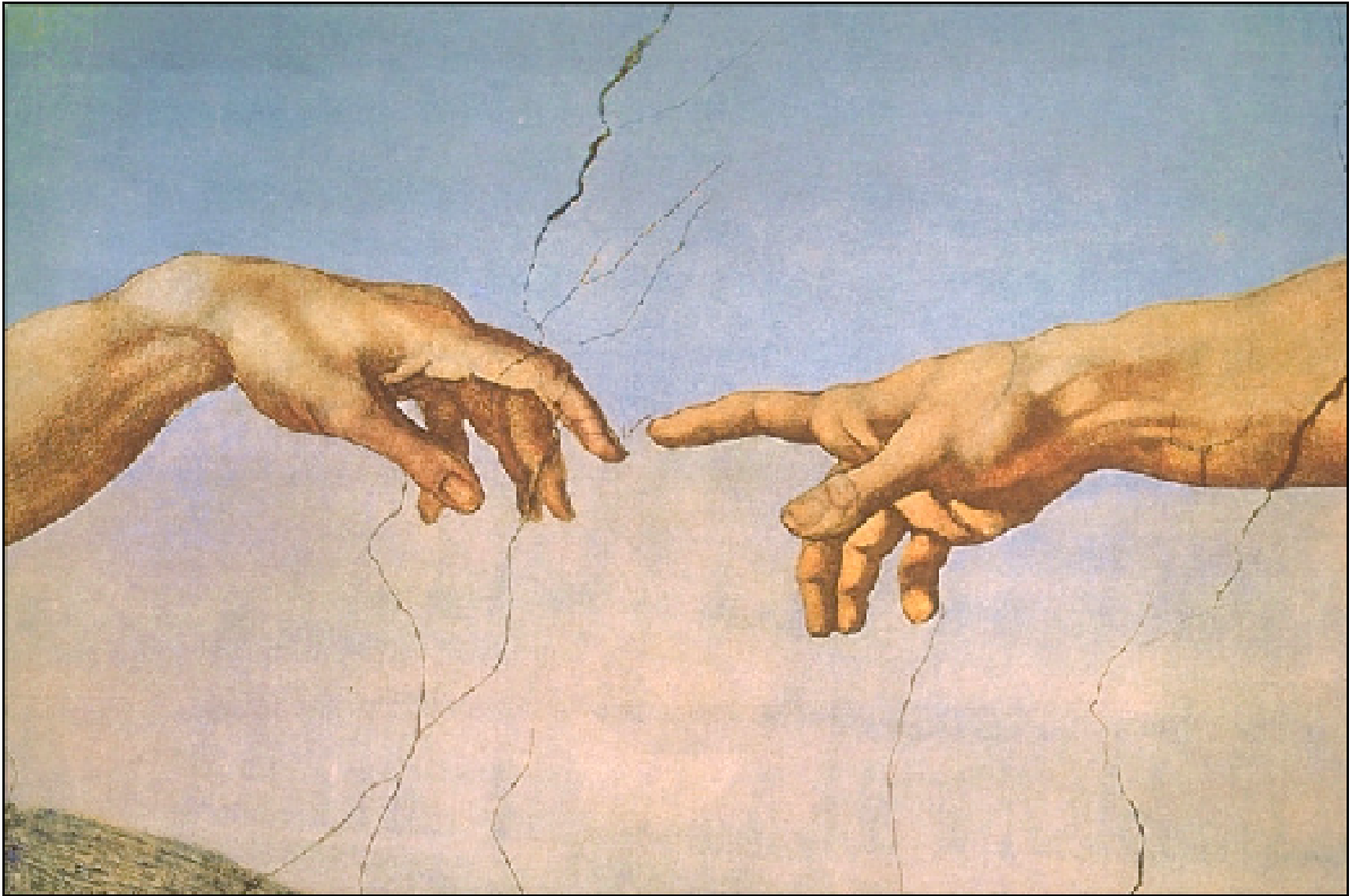
# Visual effects glass texture





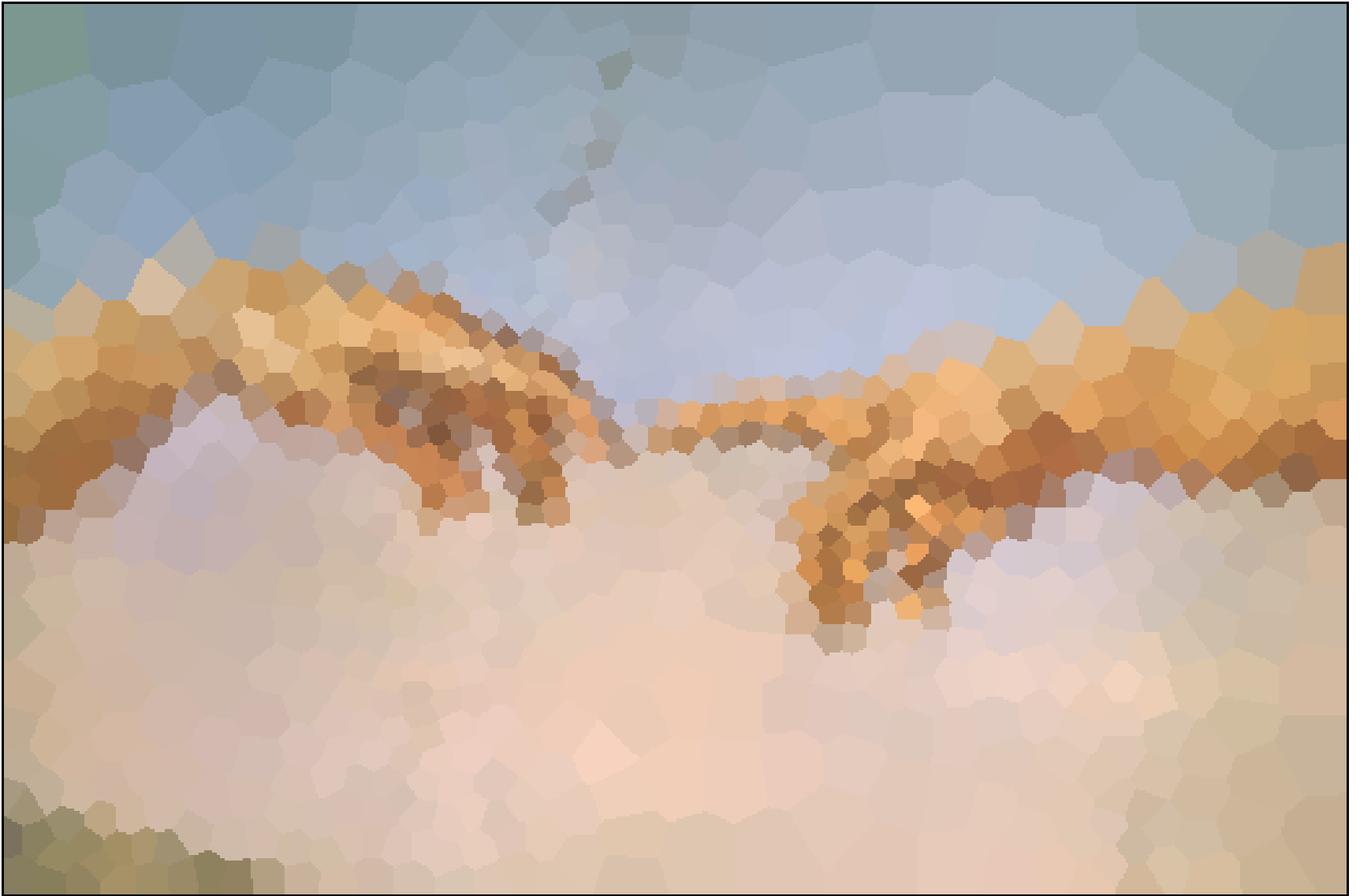


# Results

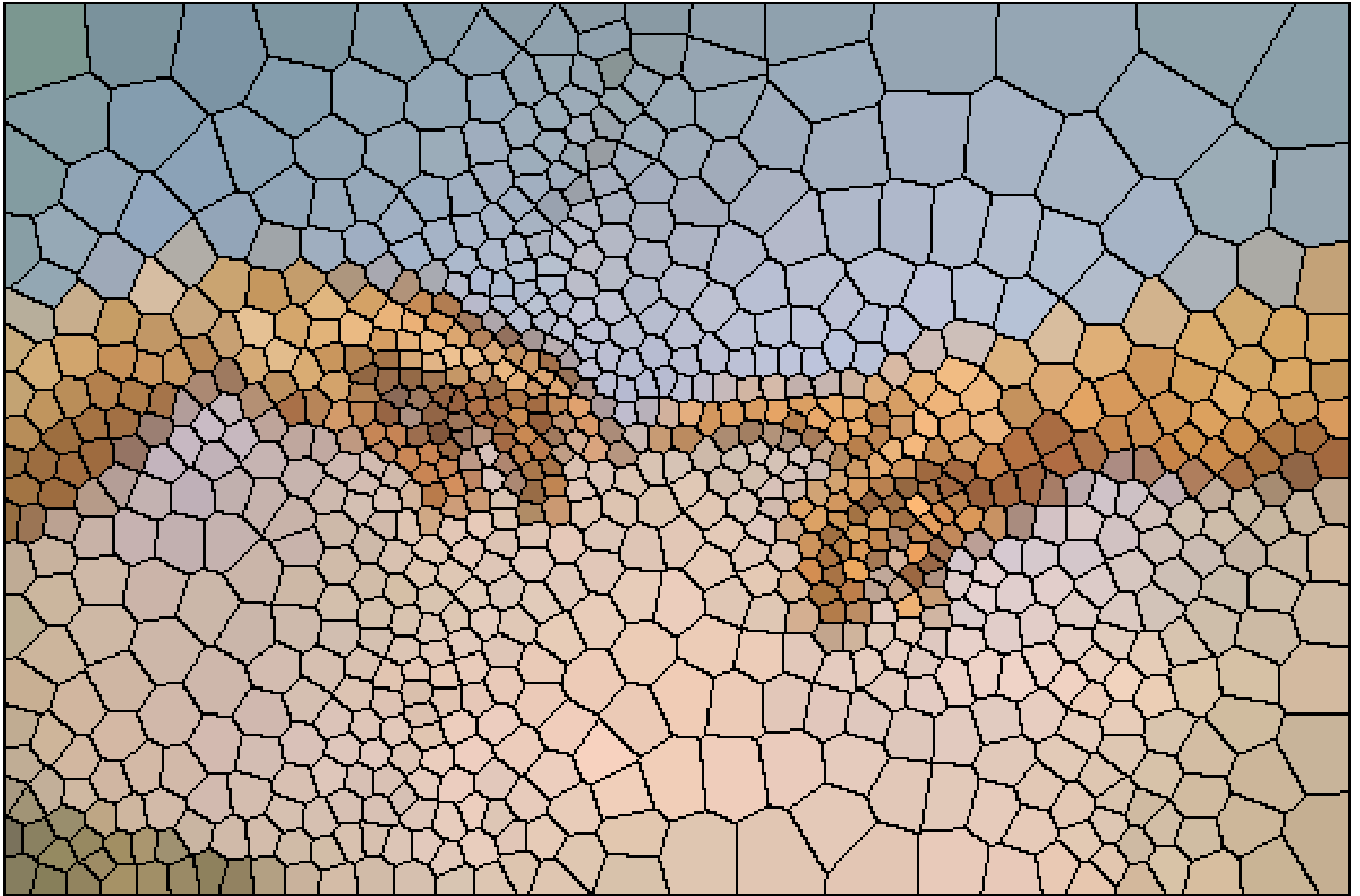


Original image

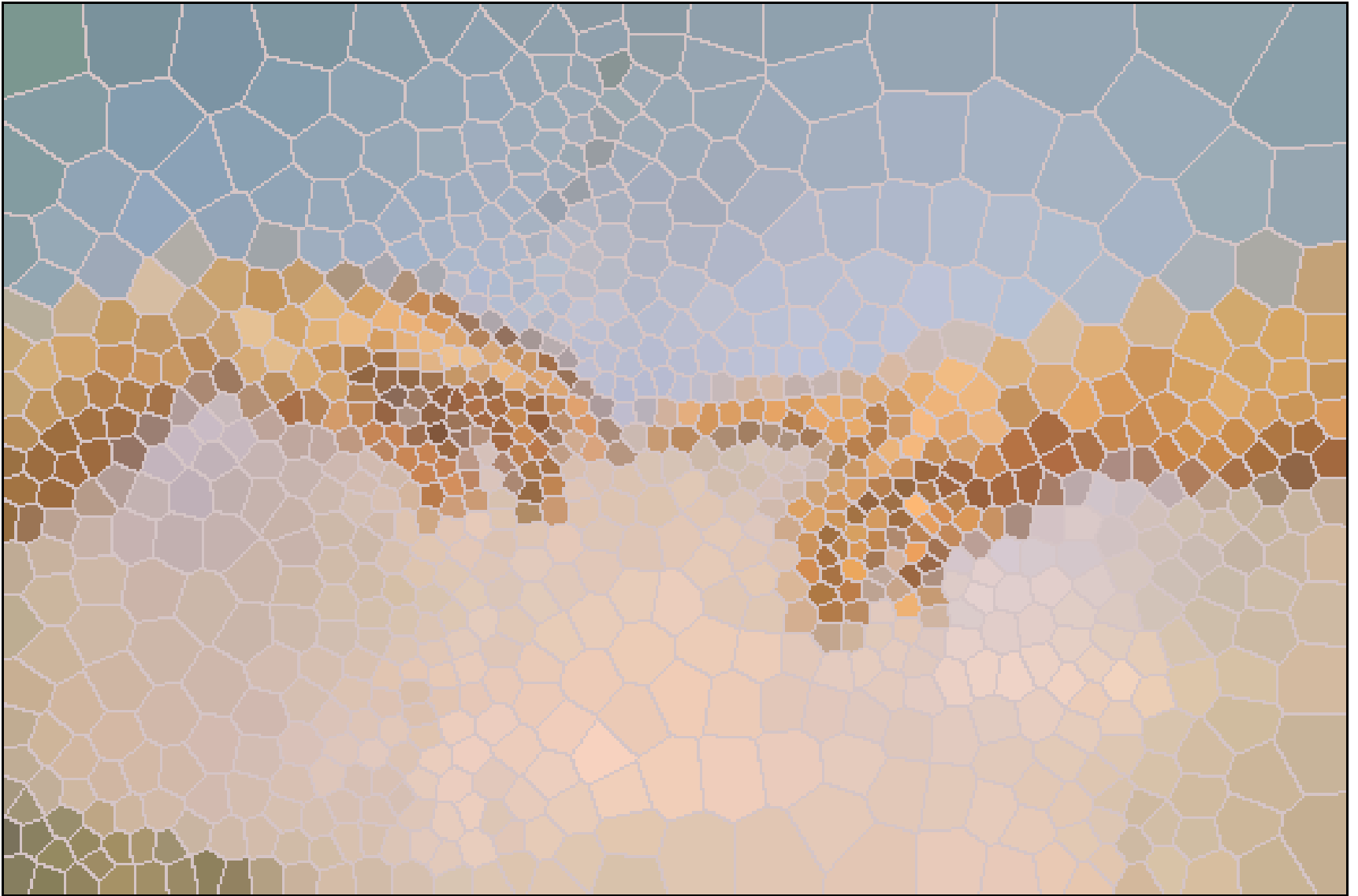




Painting effect



Mosaic effect

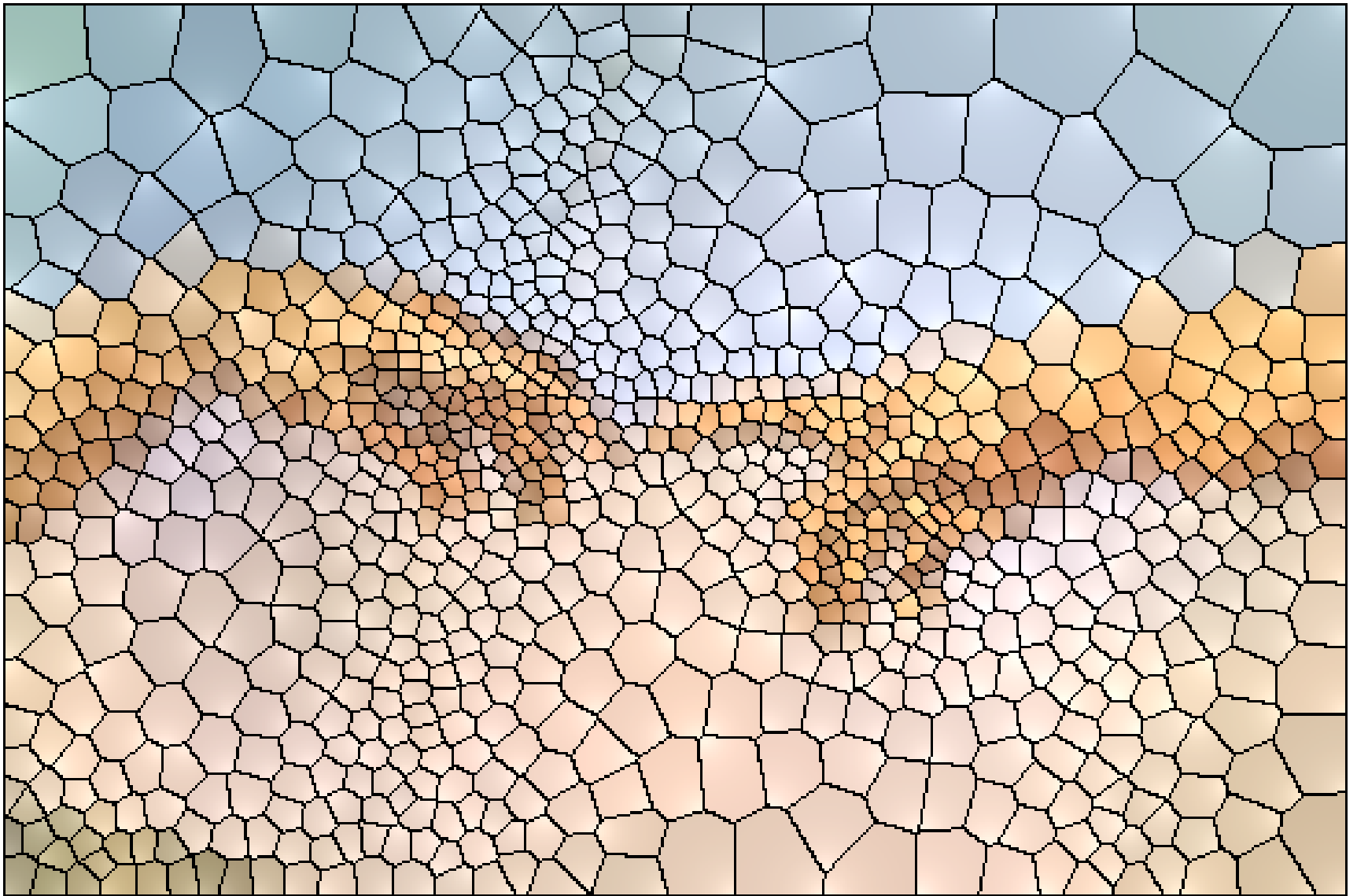


Mosaic effect

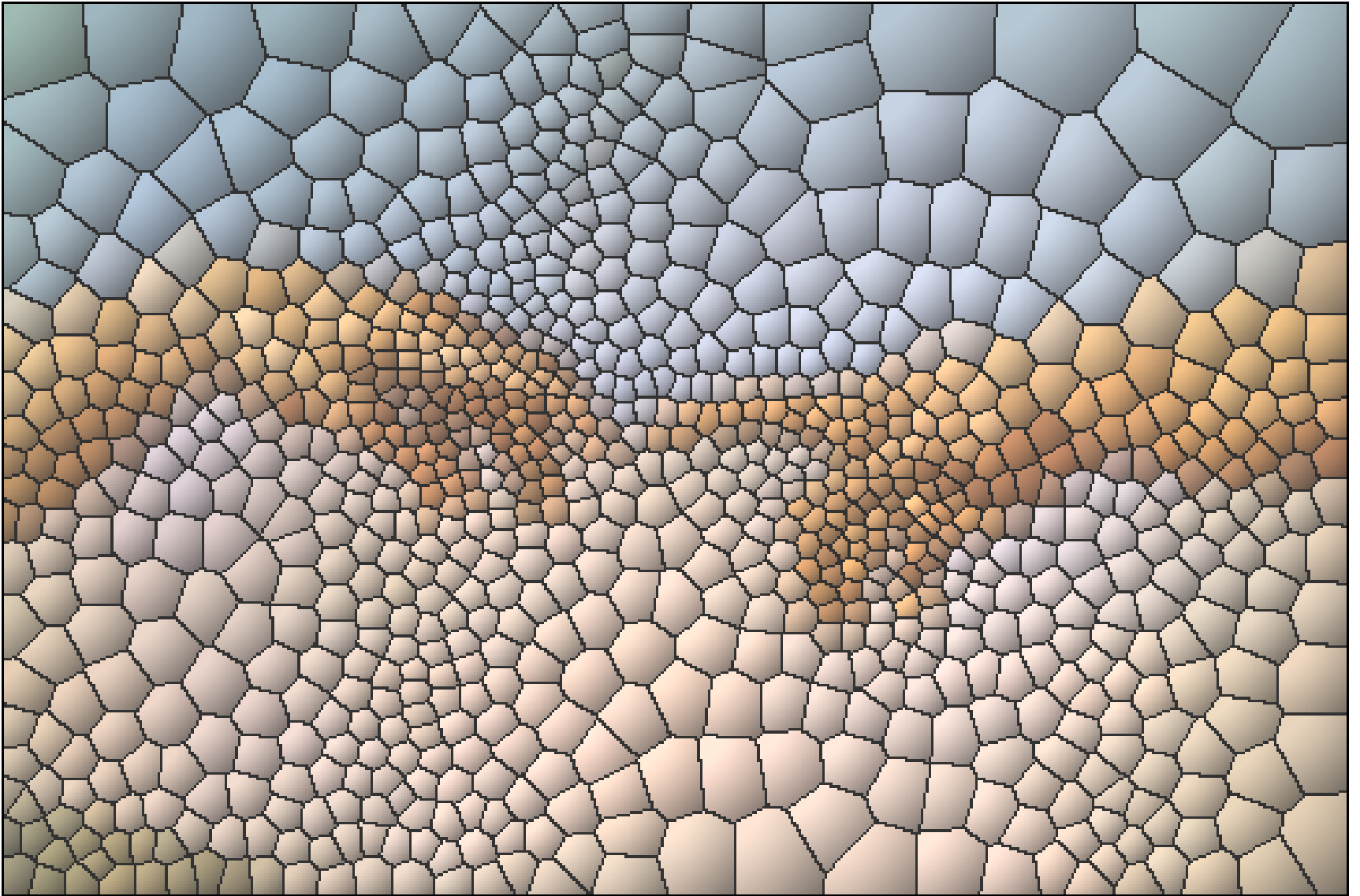


Stained-glass effect





Stained-glass effect



Quilt effect

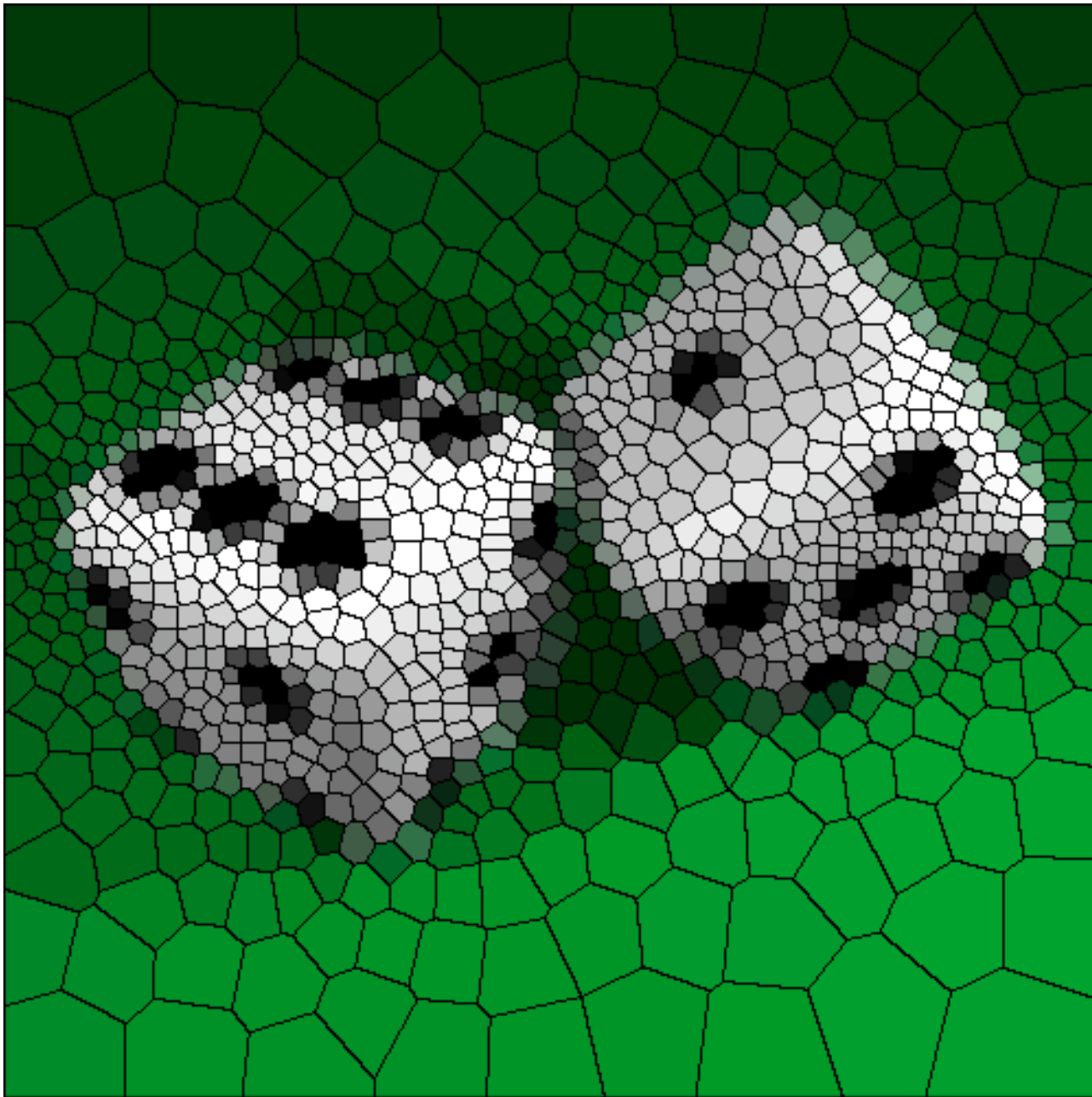


Original image

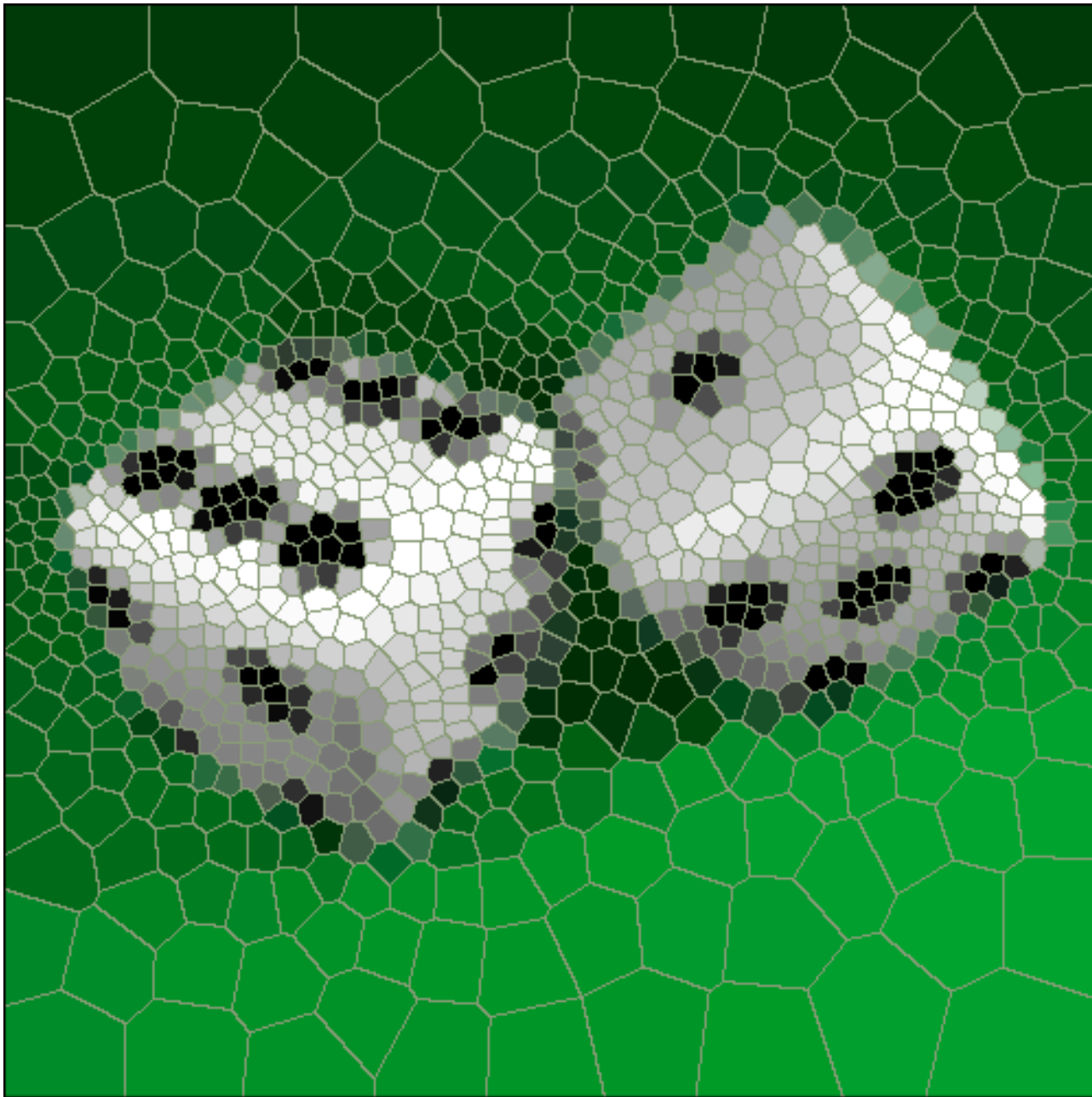


Painting effect

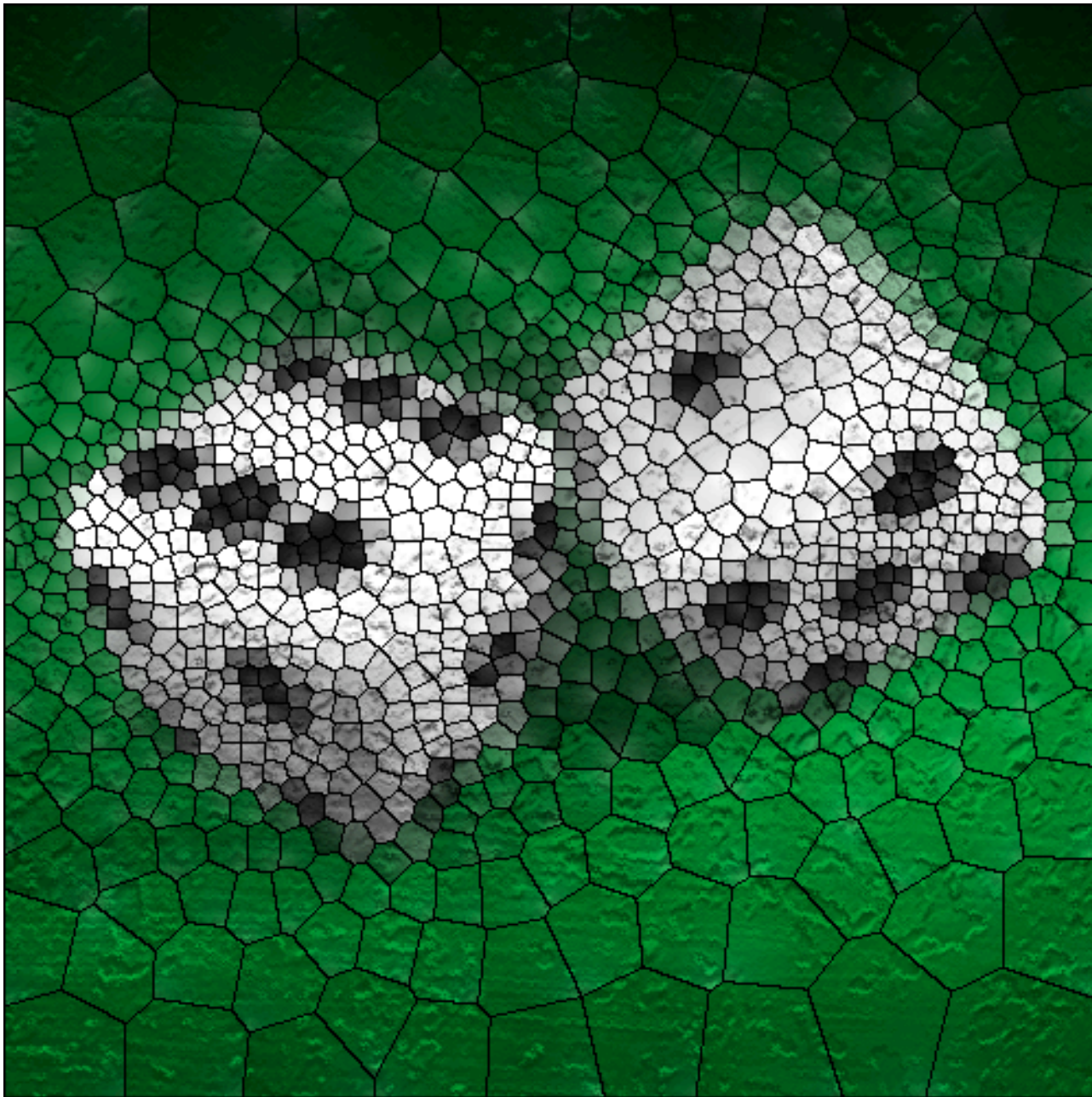




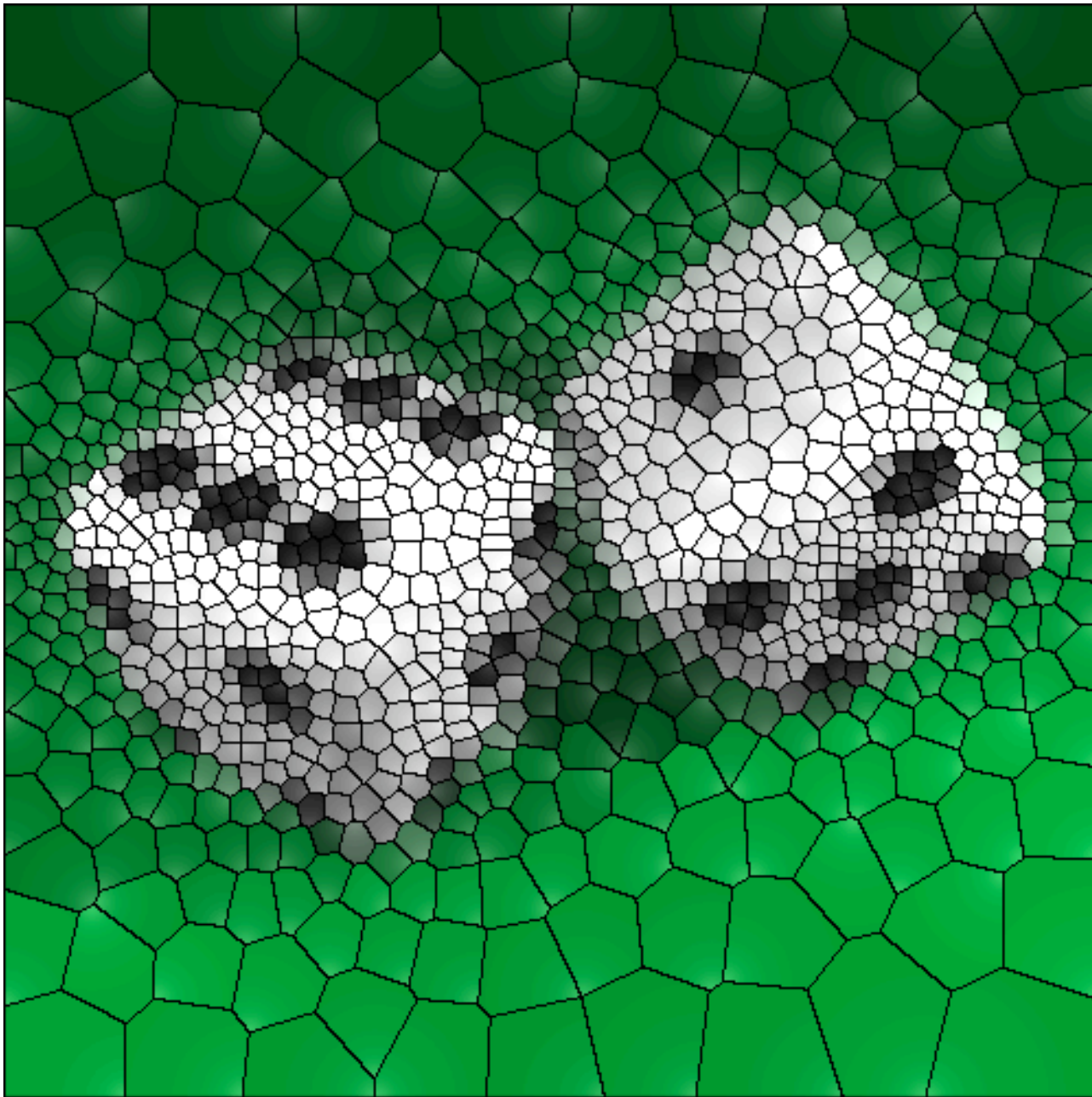
Mosaic effect



Mosaic effect

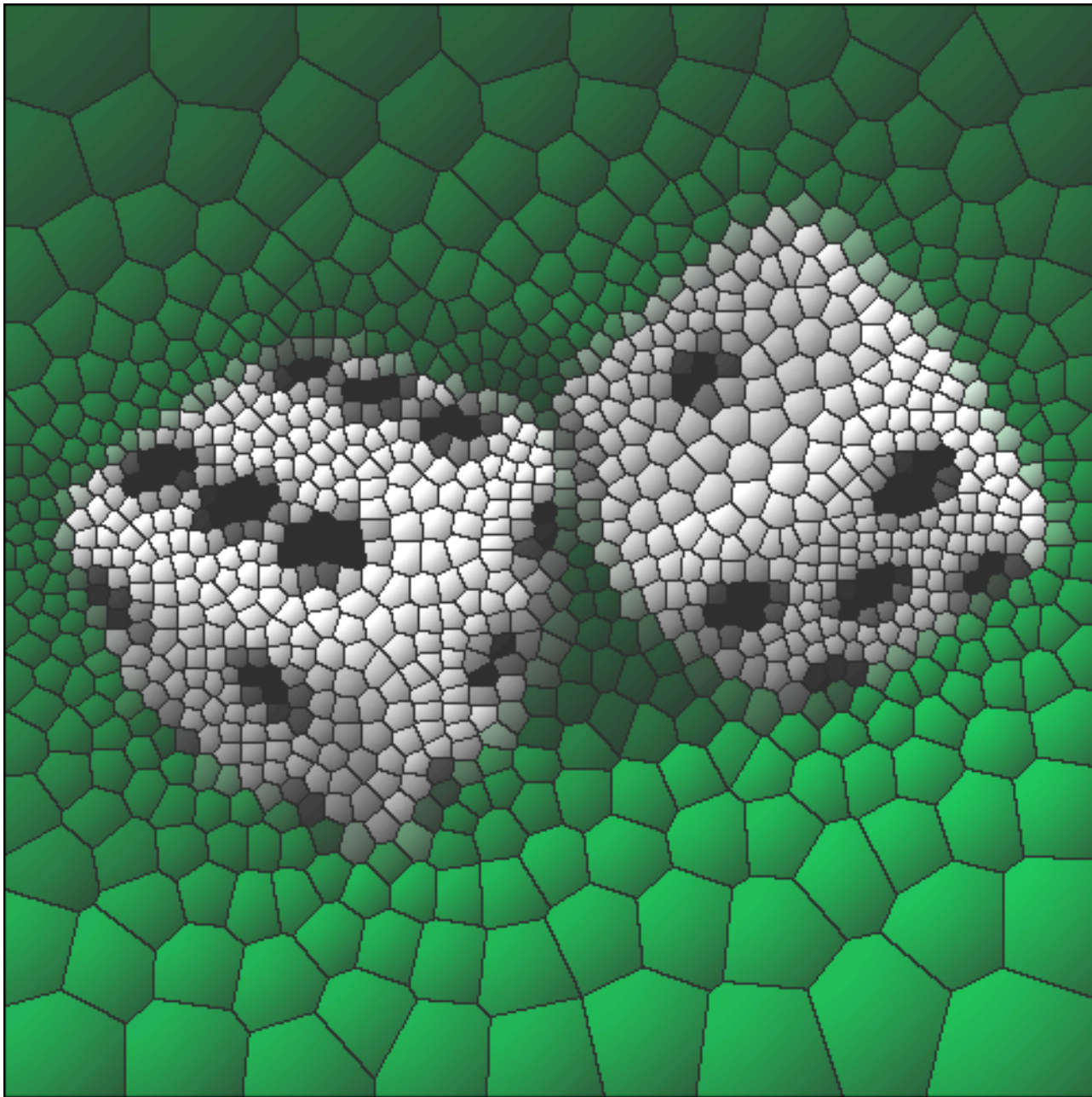


Stained-glass effect



Stained-glass effect





Quilt effect

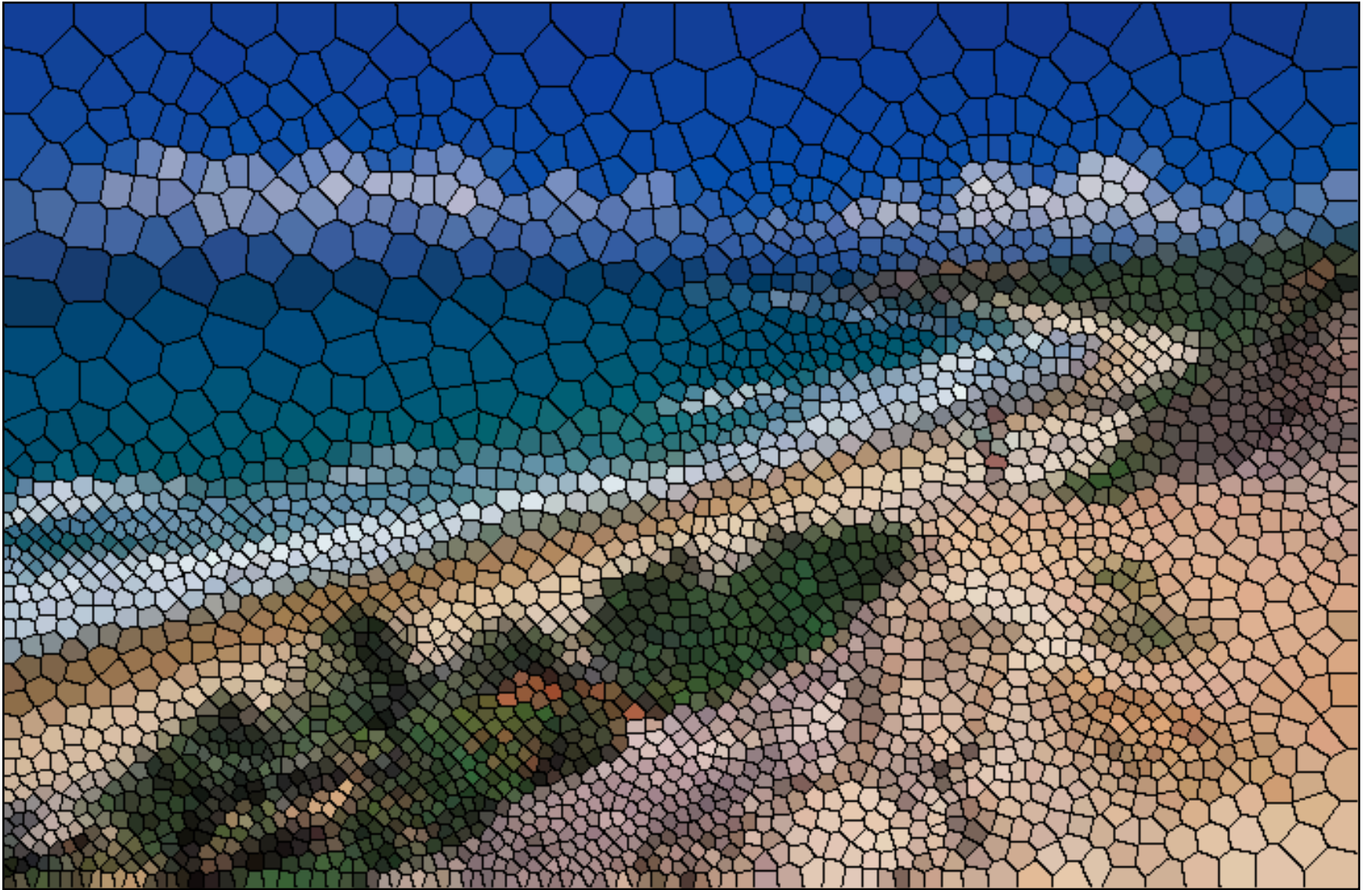




Original image



Painting effect



Mosaic effect





Mosaic effect





Stained-glass effect





Stained-glass effect



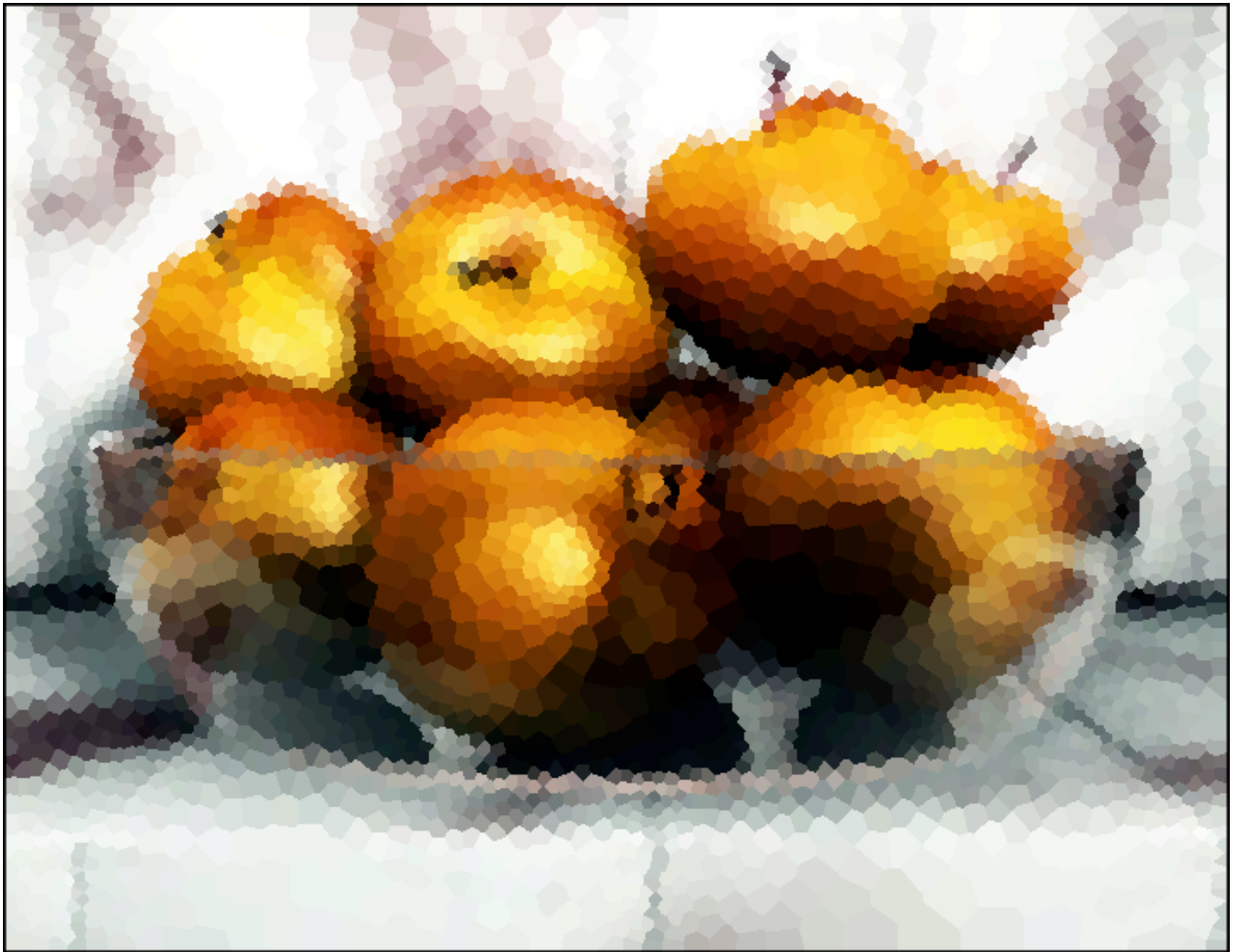


Quilt effect

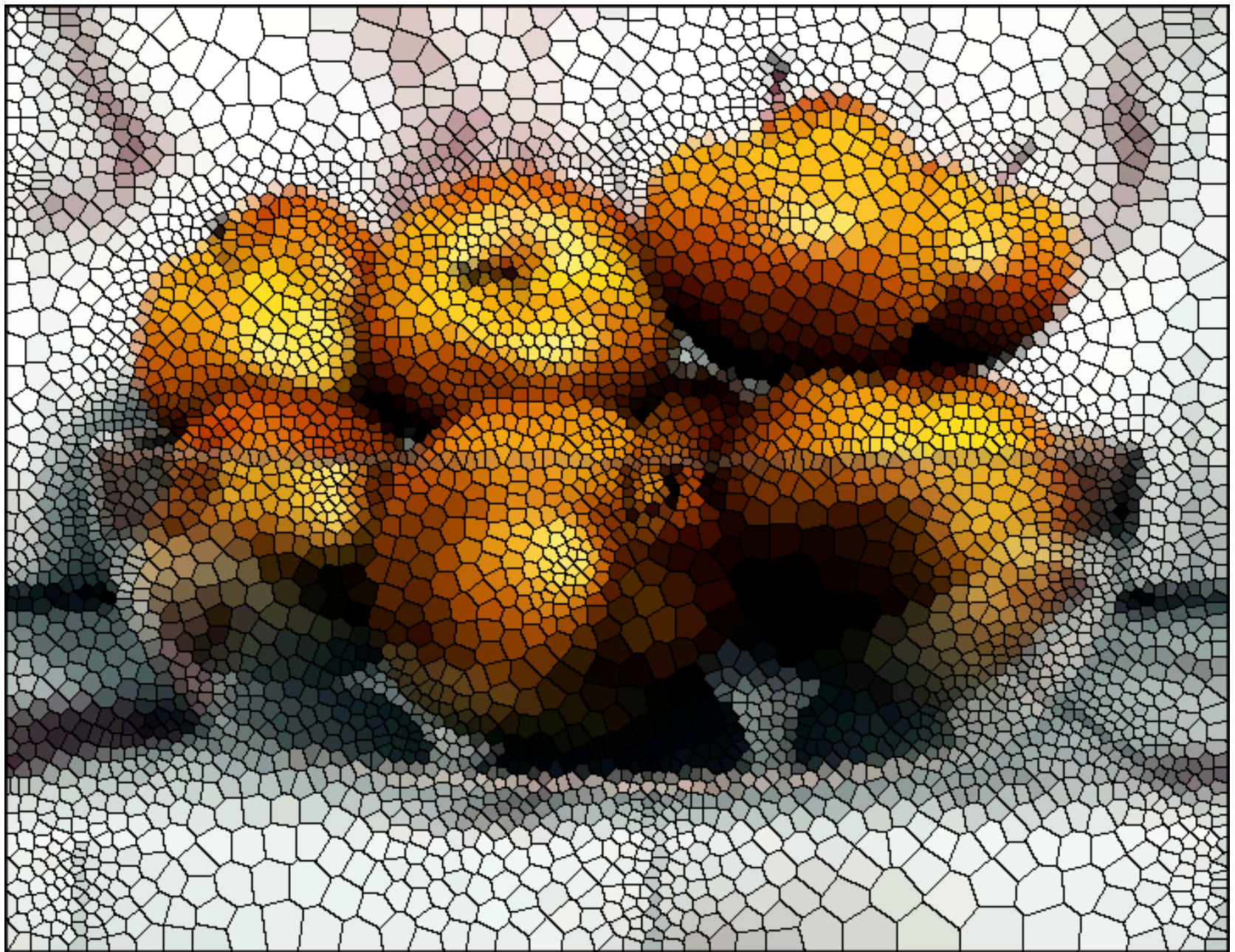


Original image



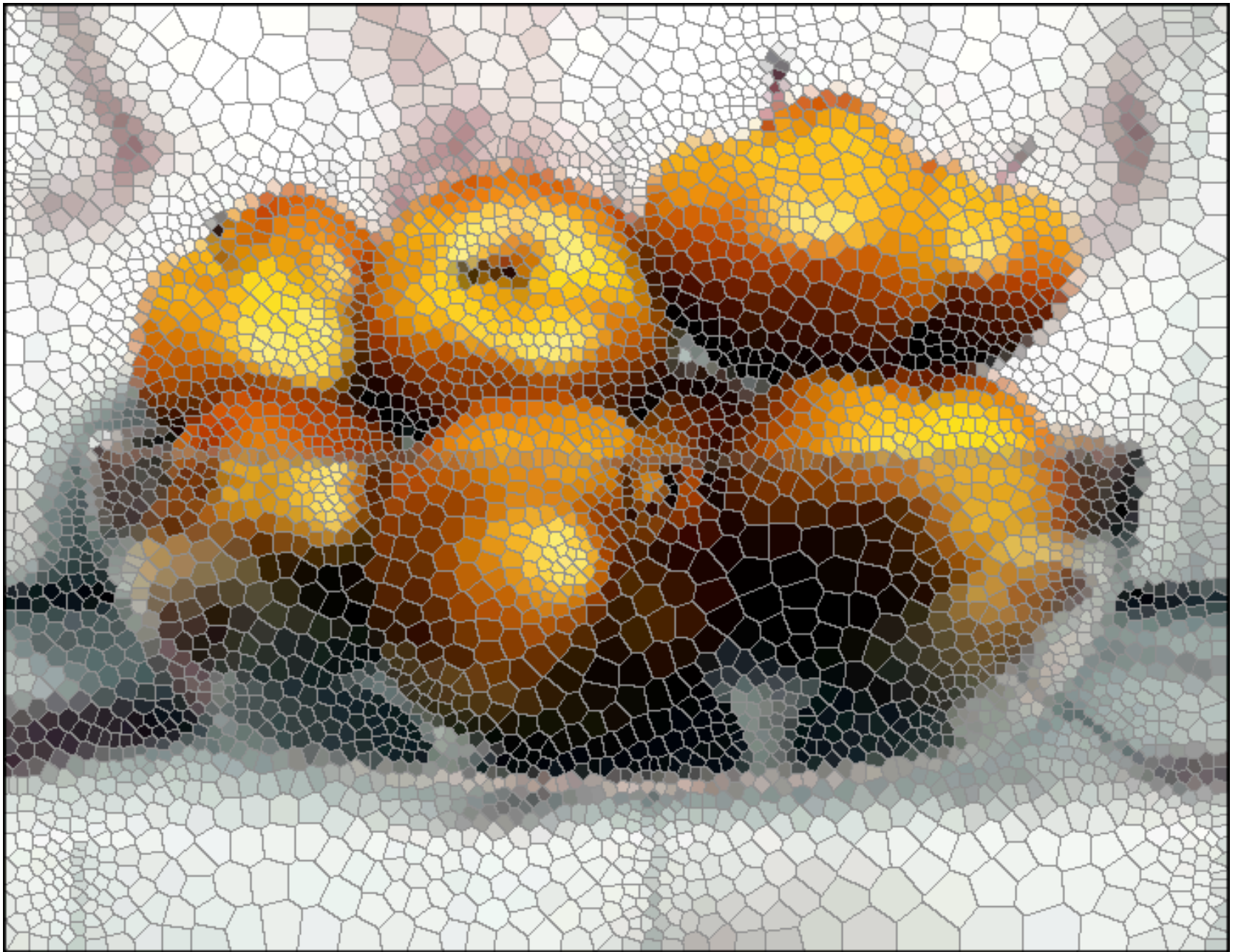


Painting effect



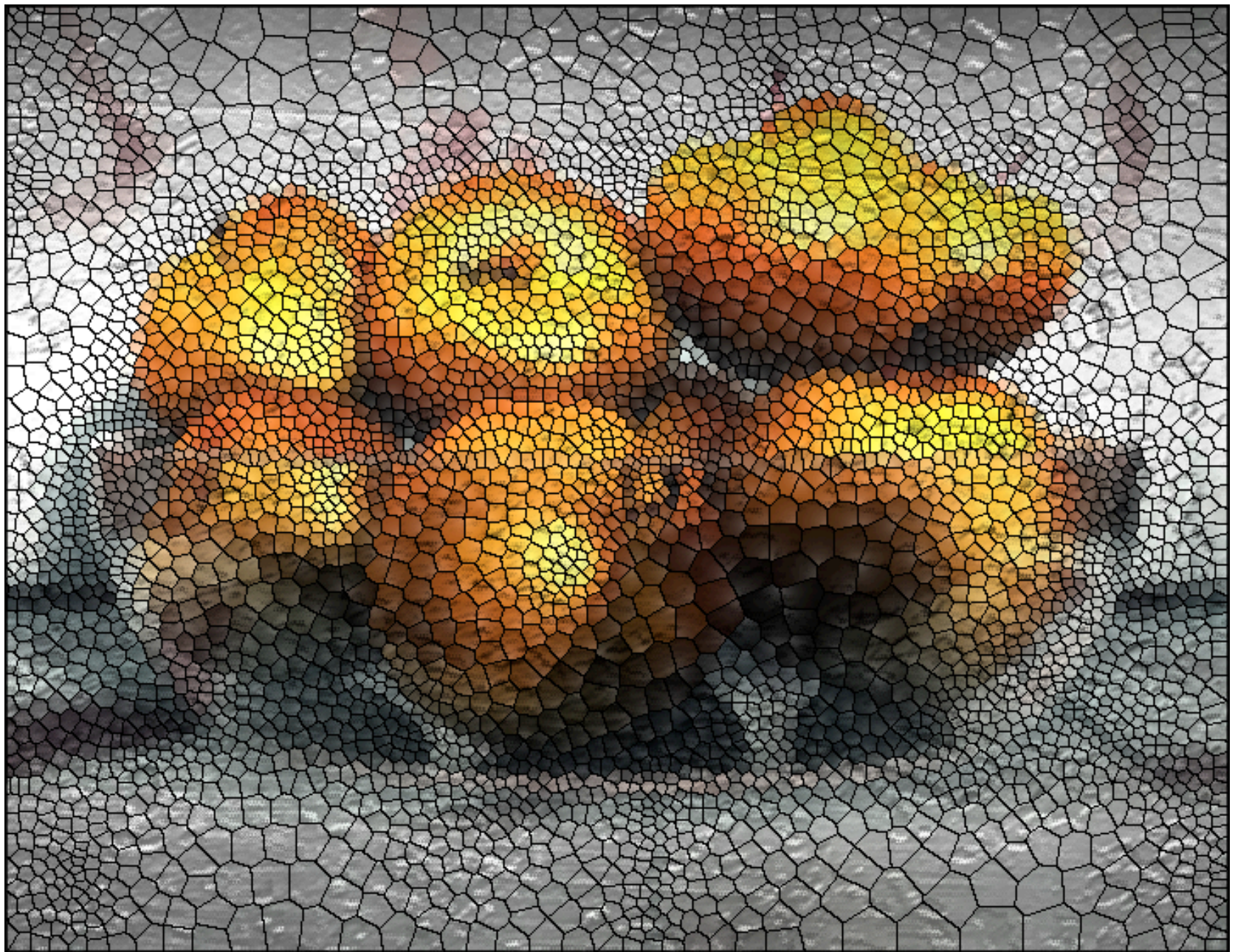
Mosaic effect





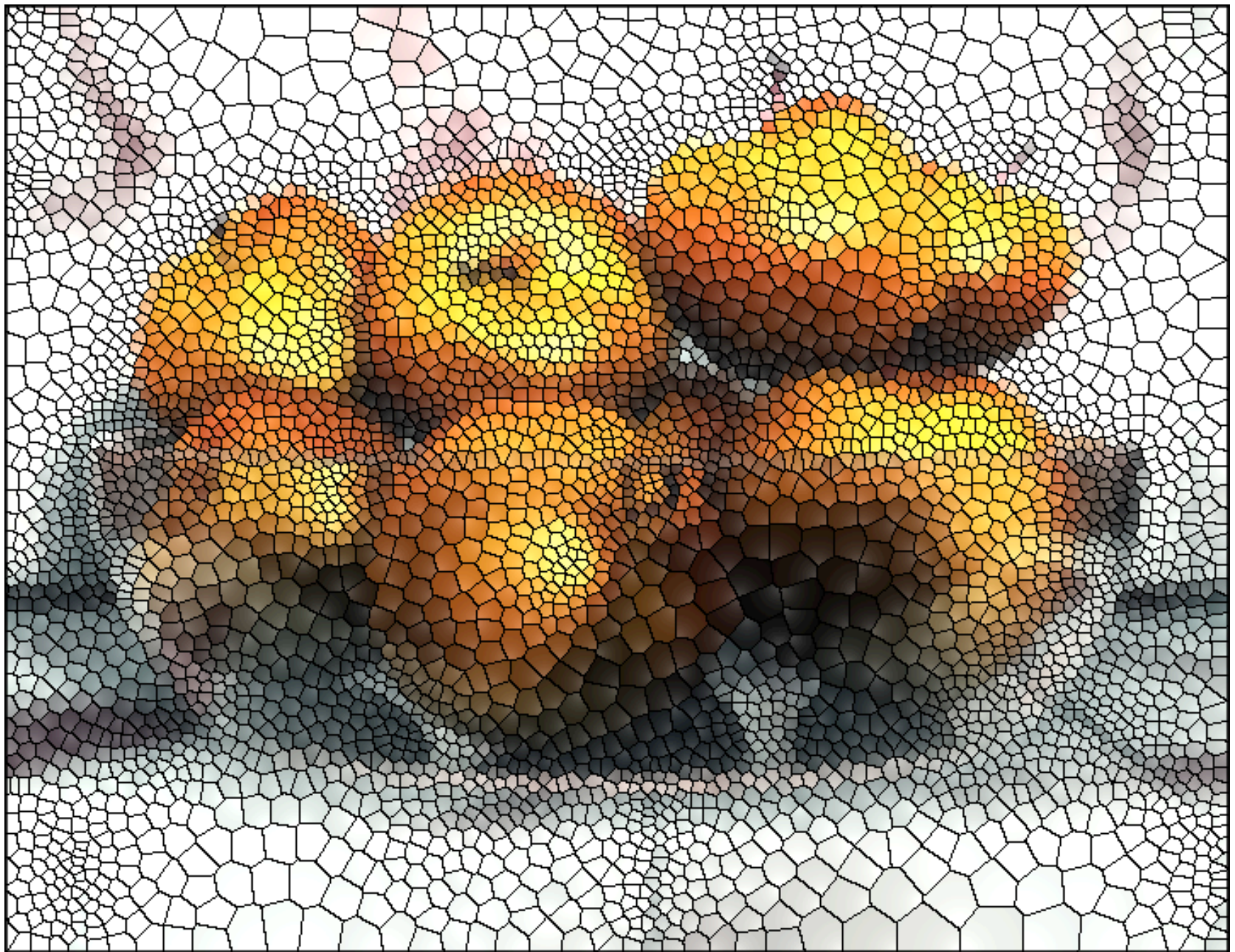
Mosaic effect





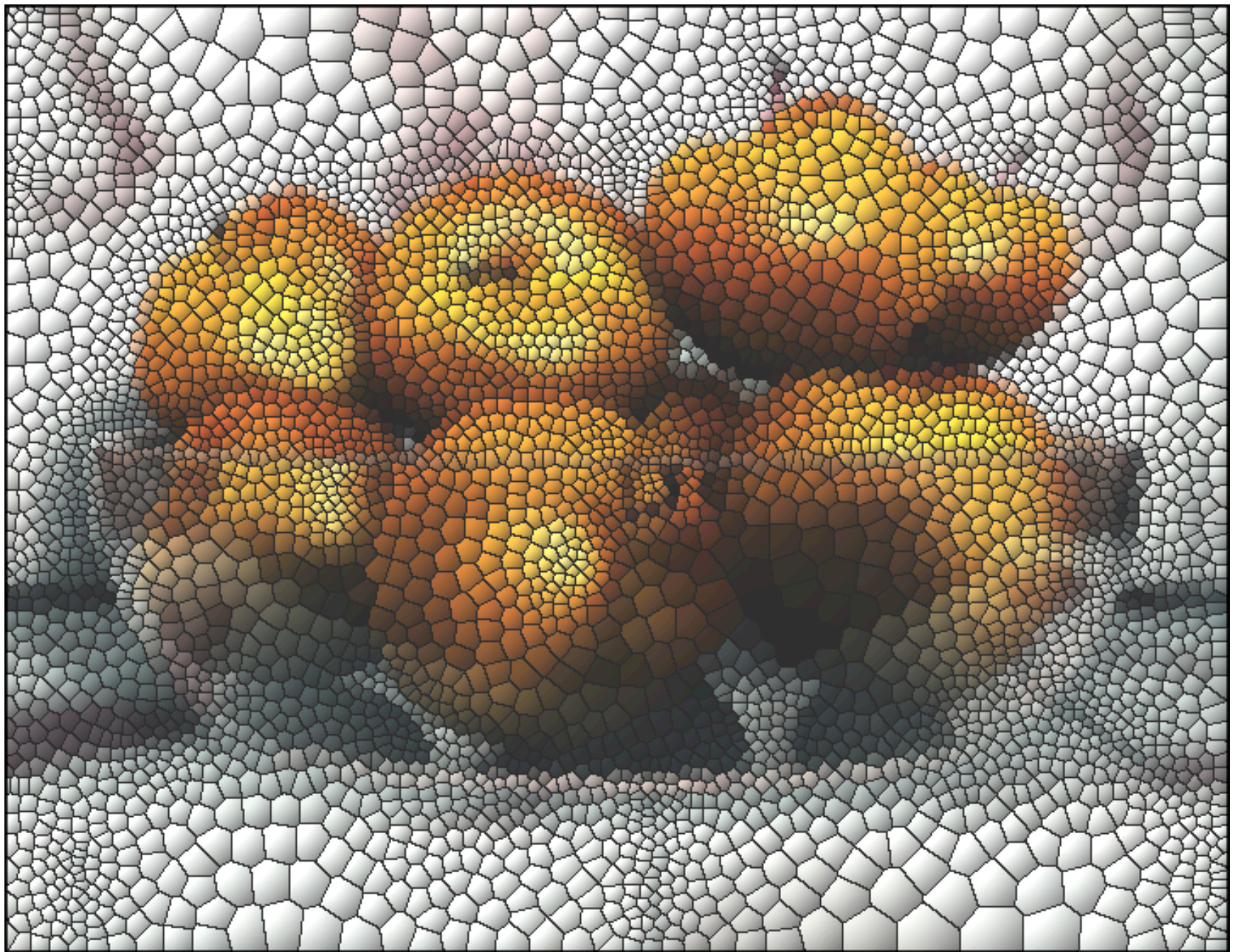
Stained-glass effect



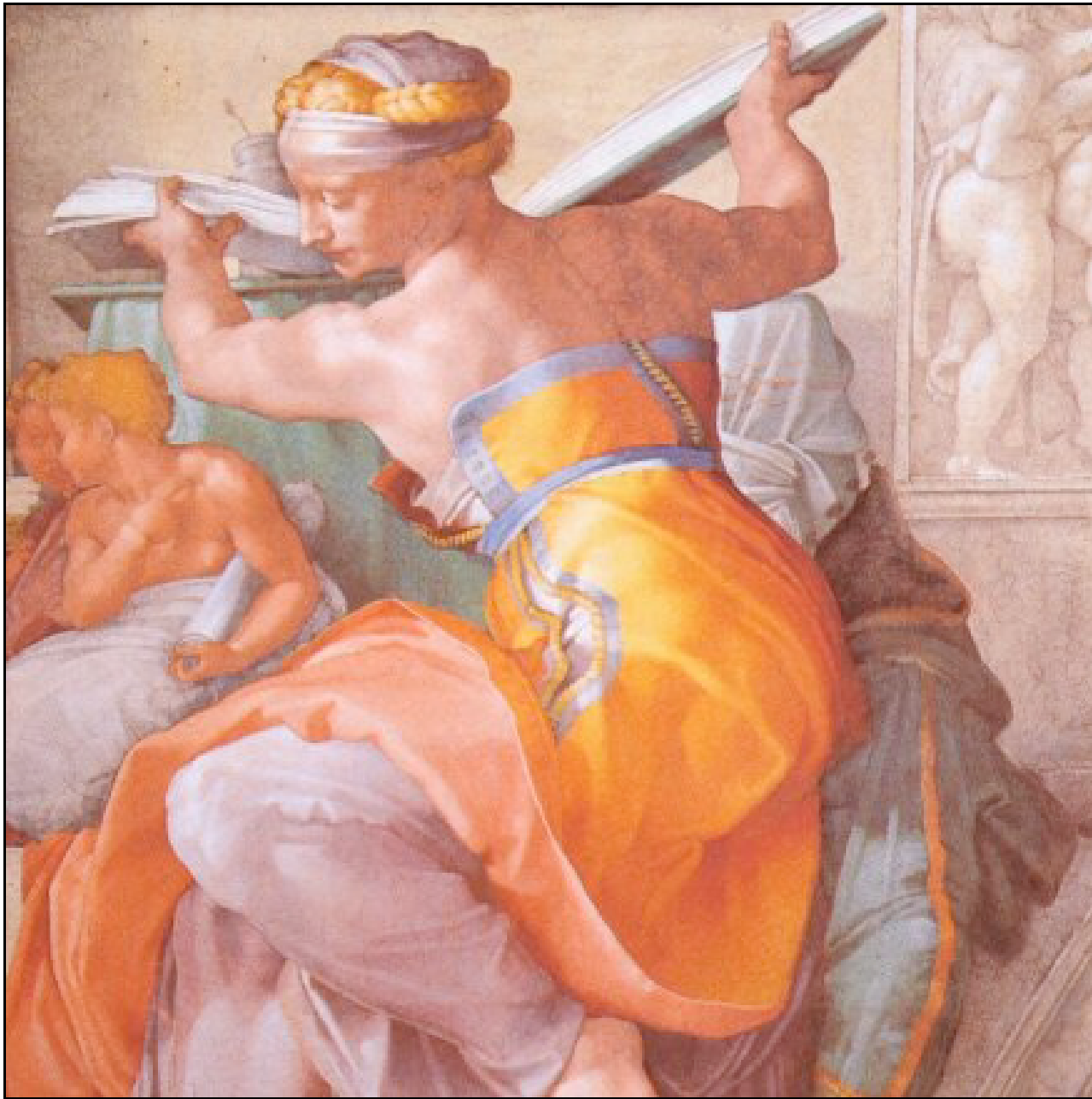


Stained-glass effect



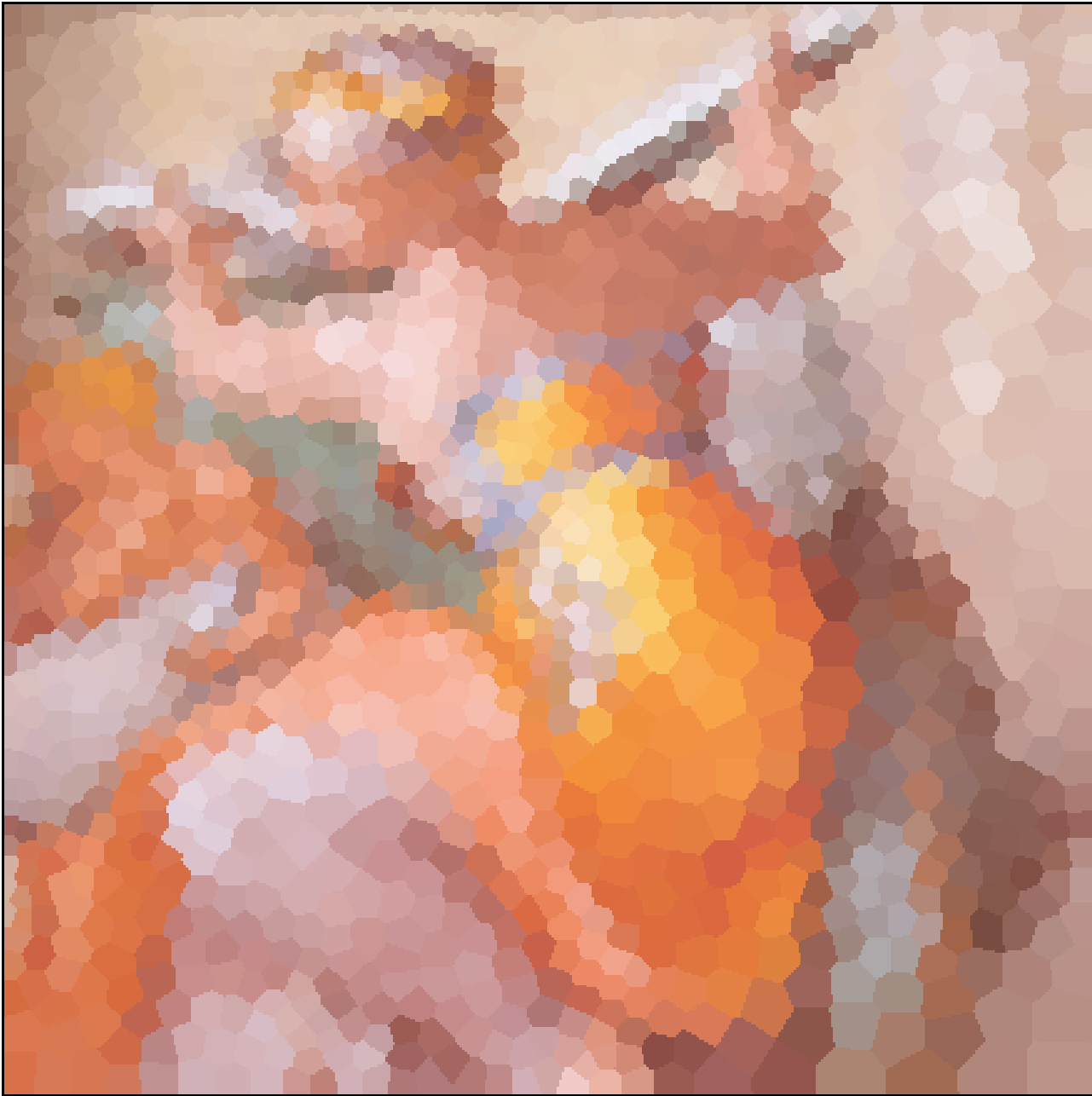


Quilt effect

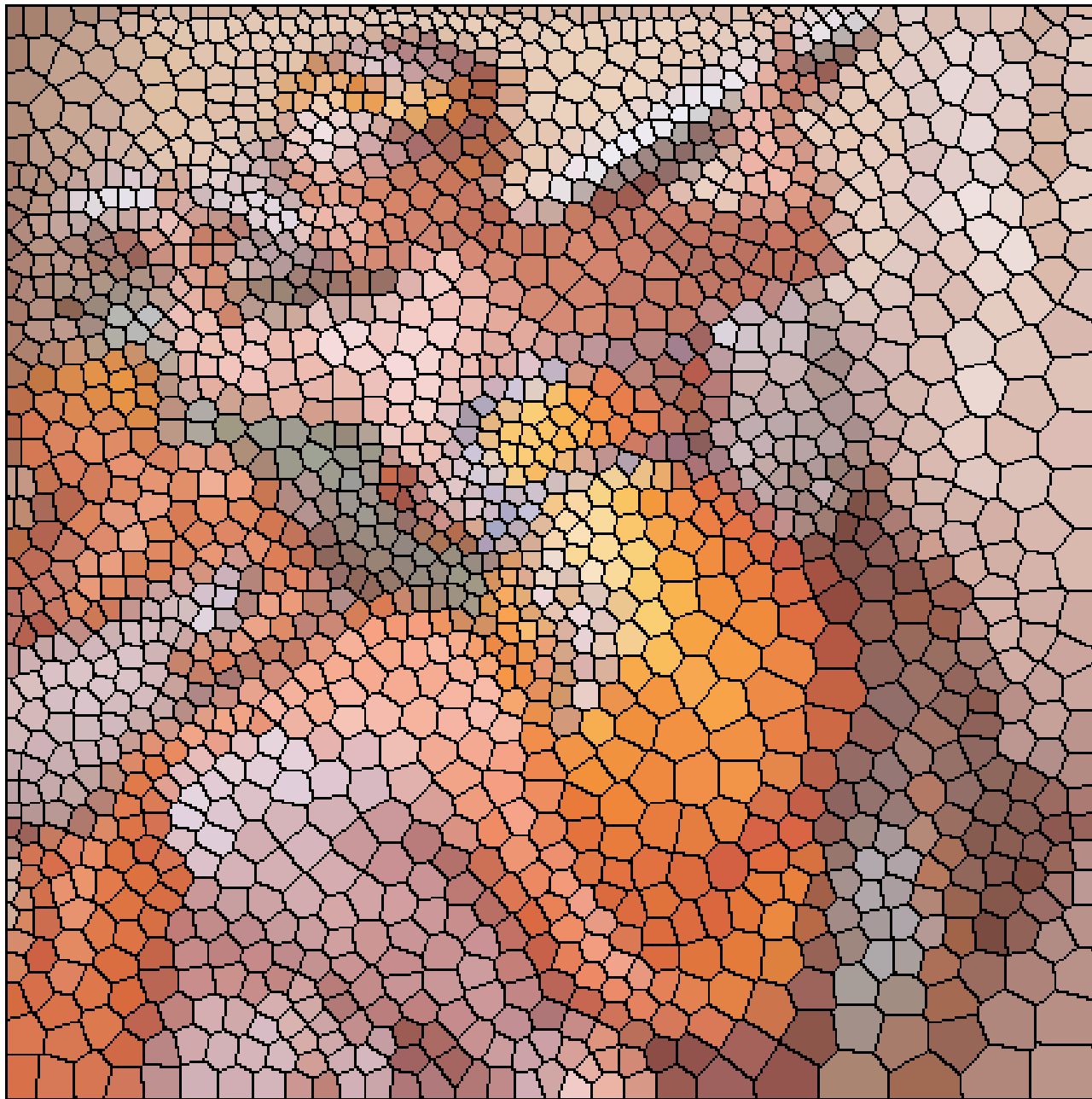


Original image

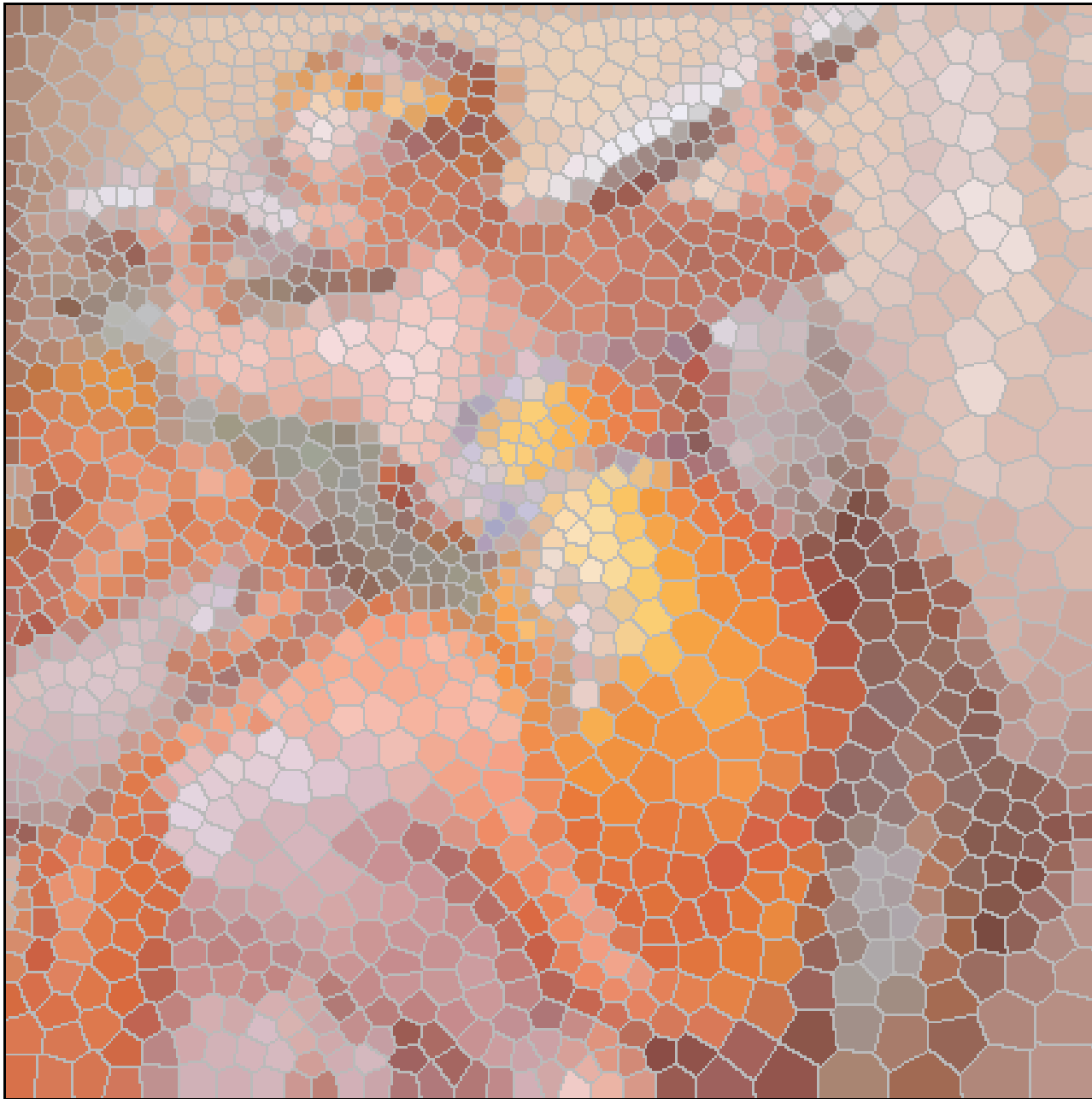




Painting effect



Mosaic effect

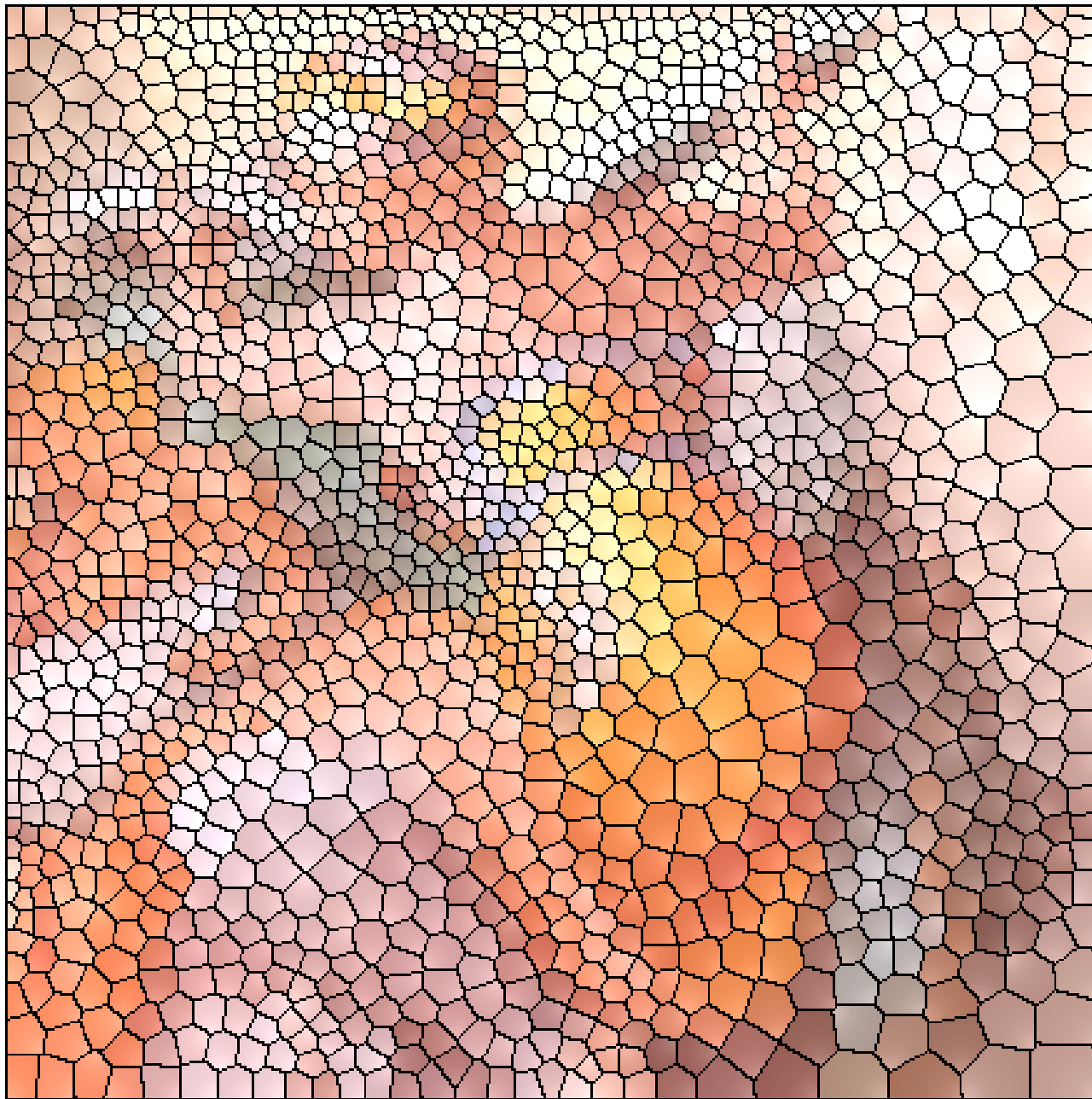


Mosaic effect



Stained-glass effect





Stained-glass effect



Quilt effect

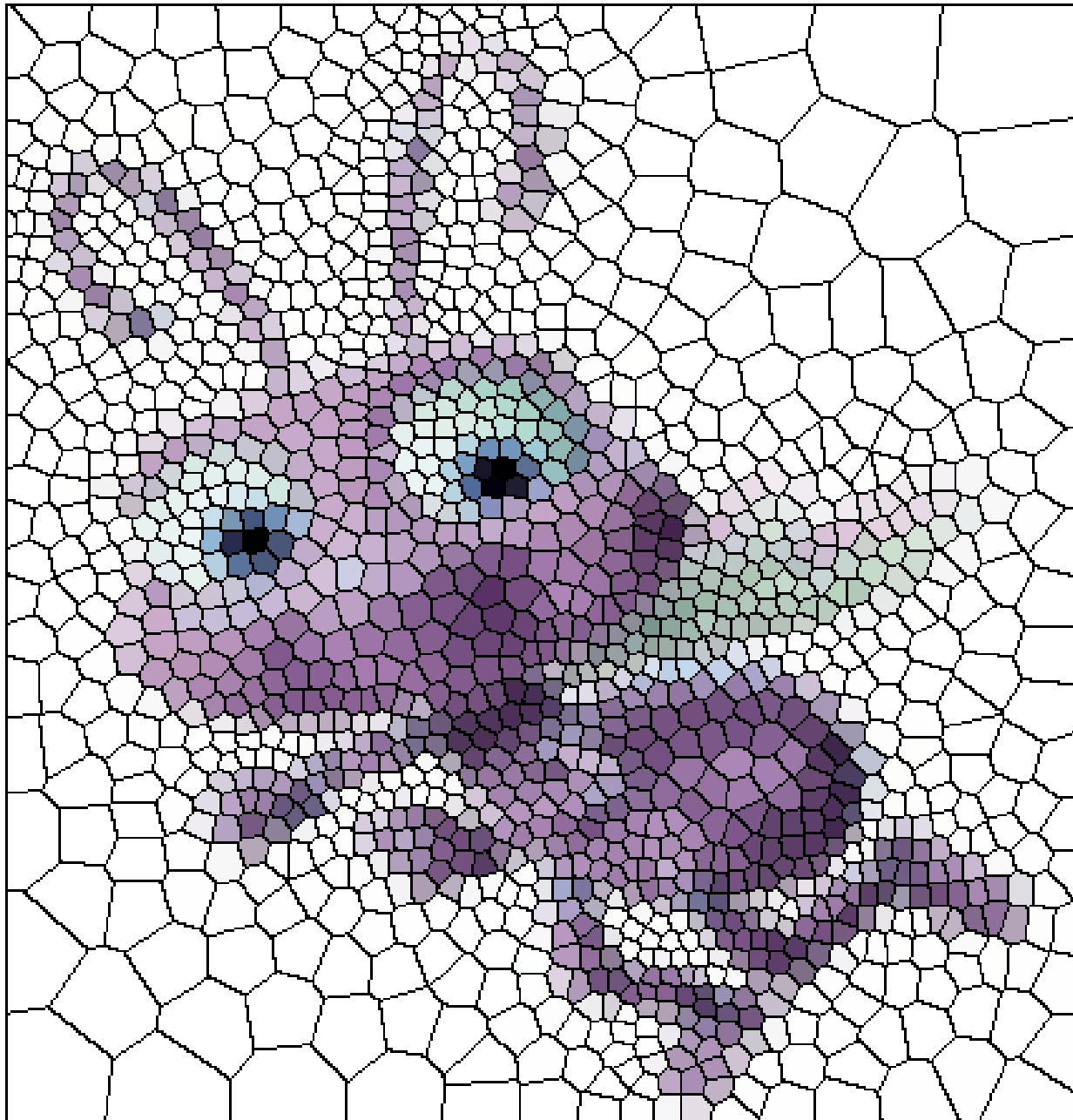


Original image

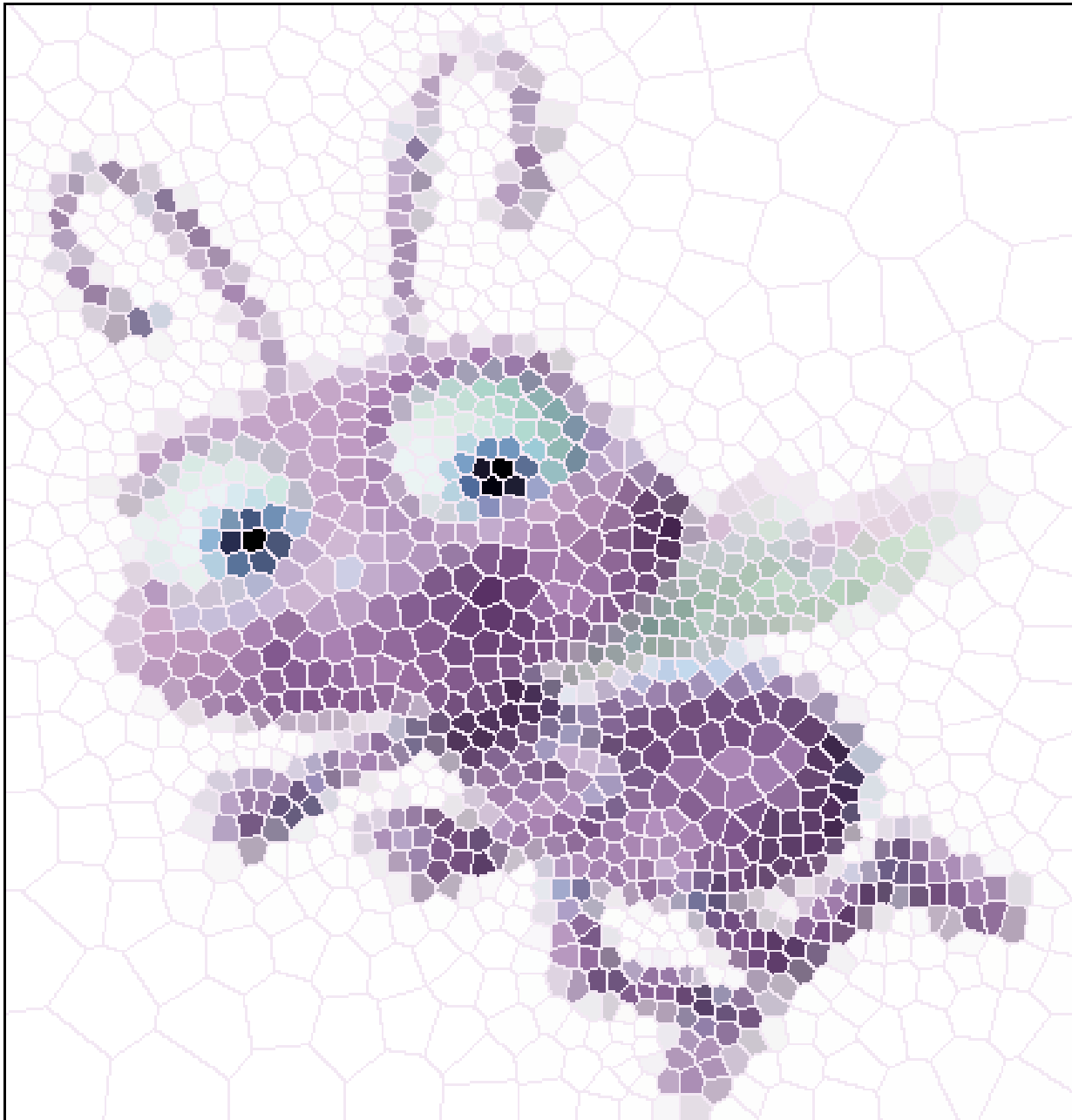


Painting effect

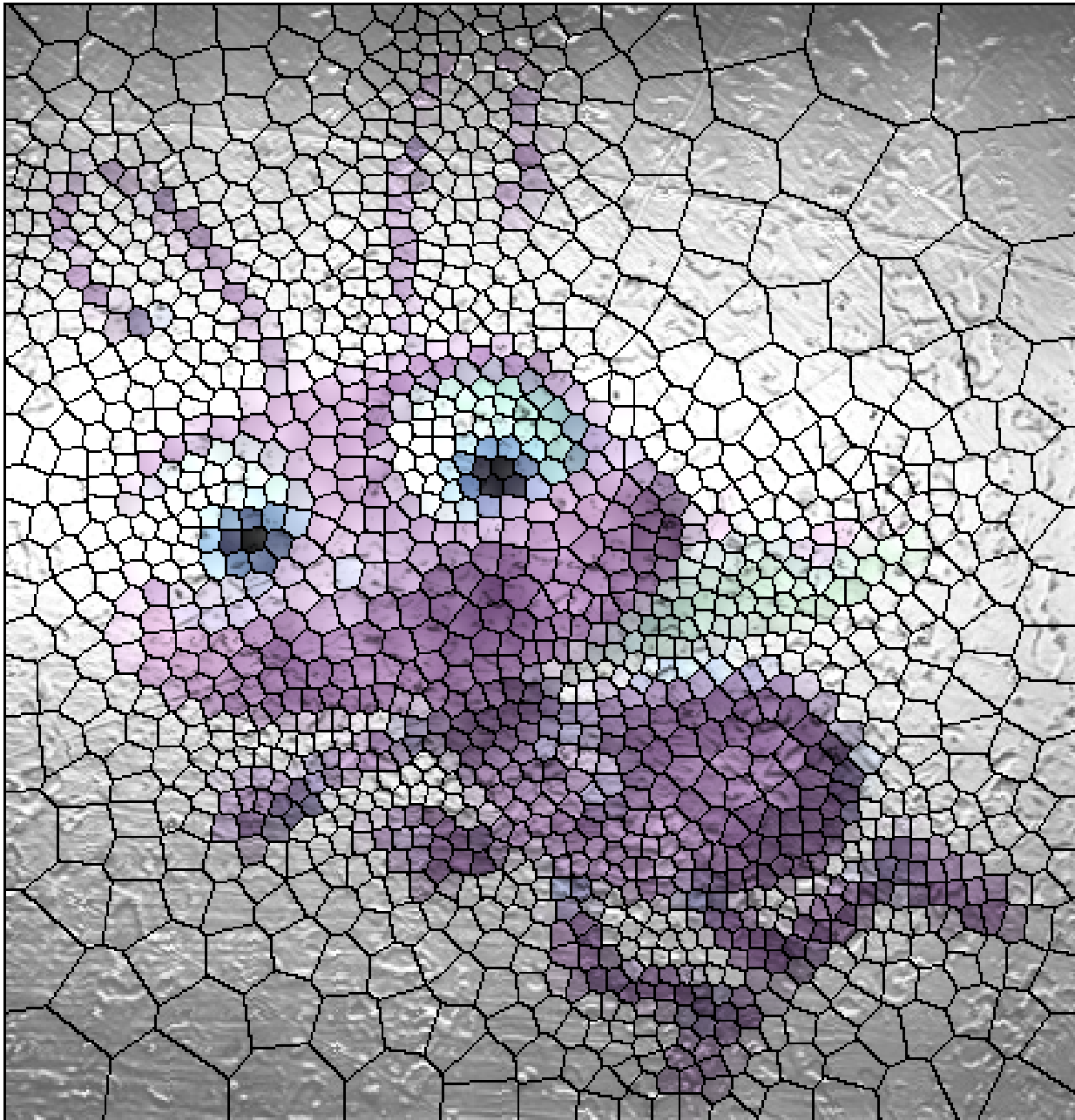




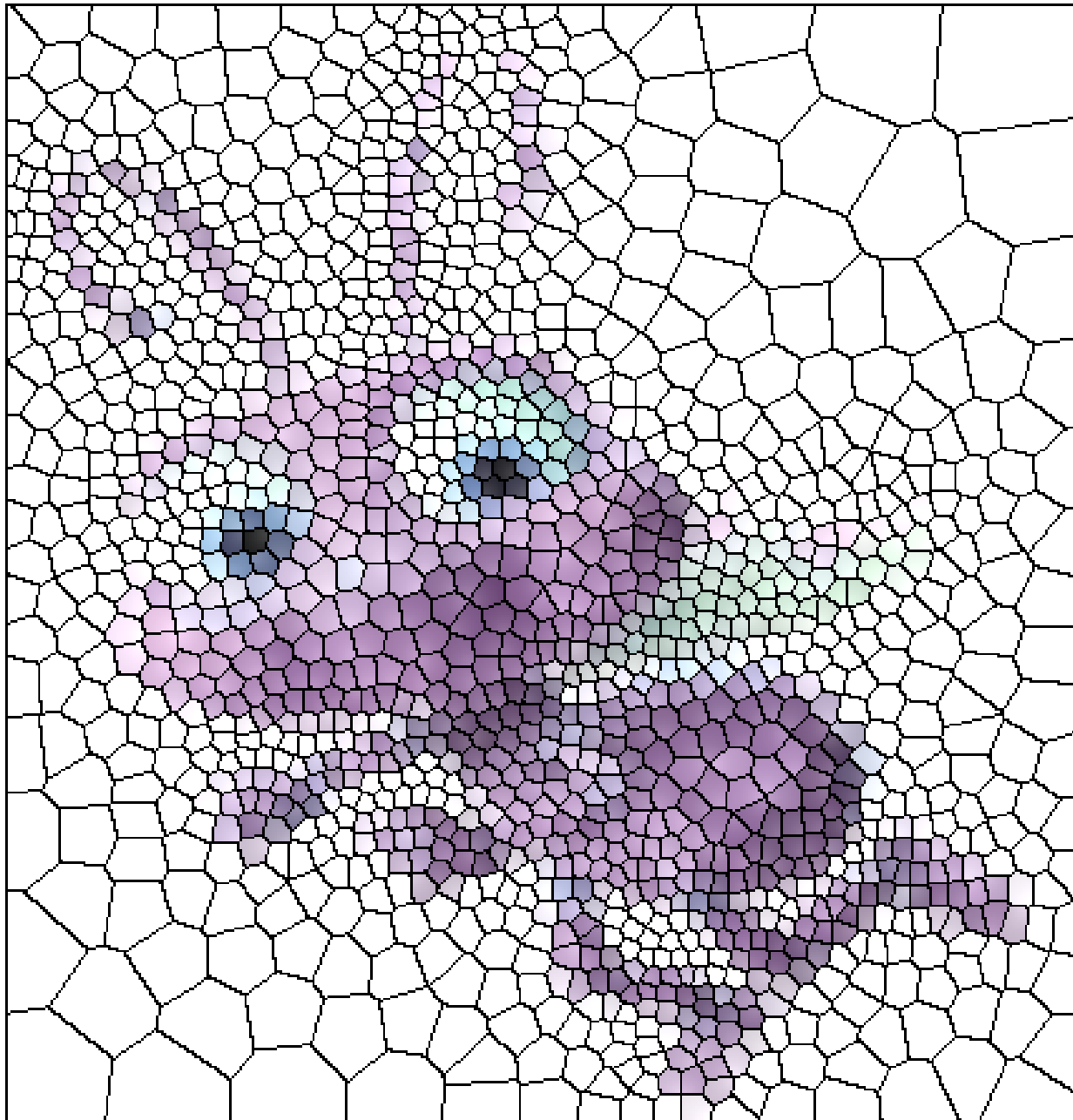
Mosaic effect



Mosaic effect

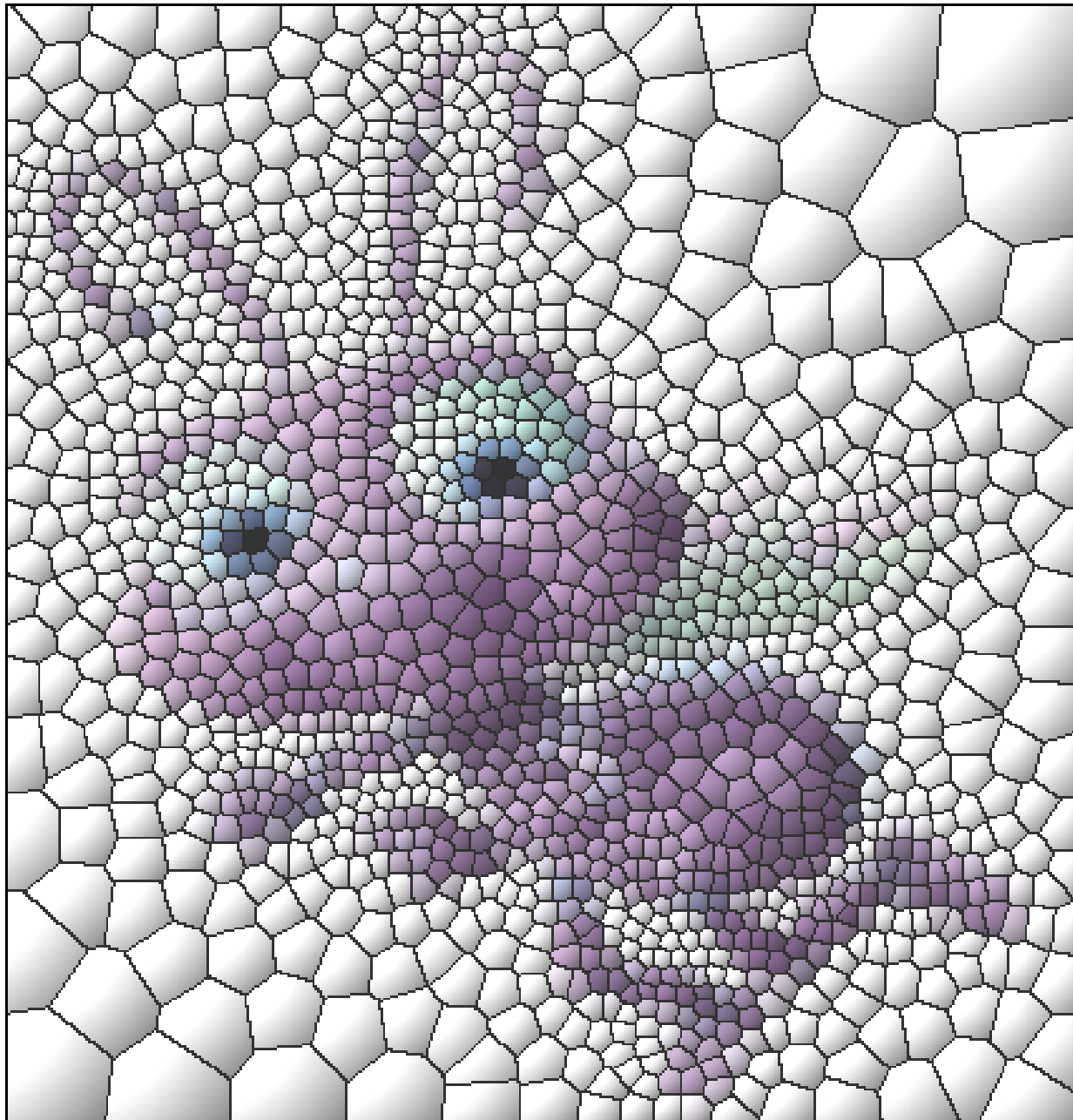


Stained-glass effect

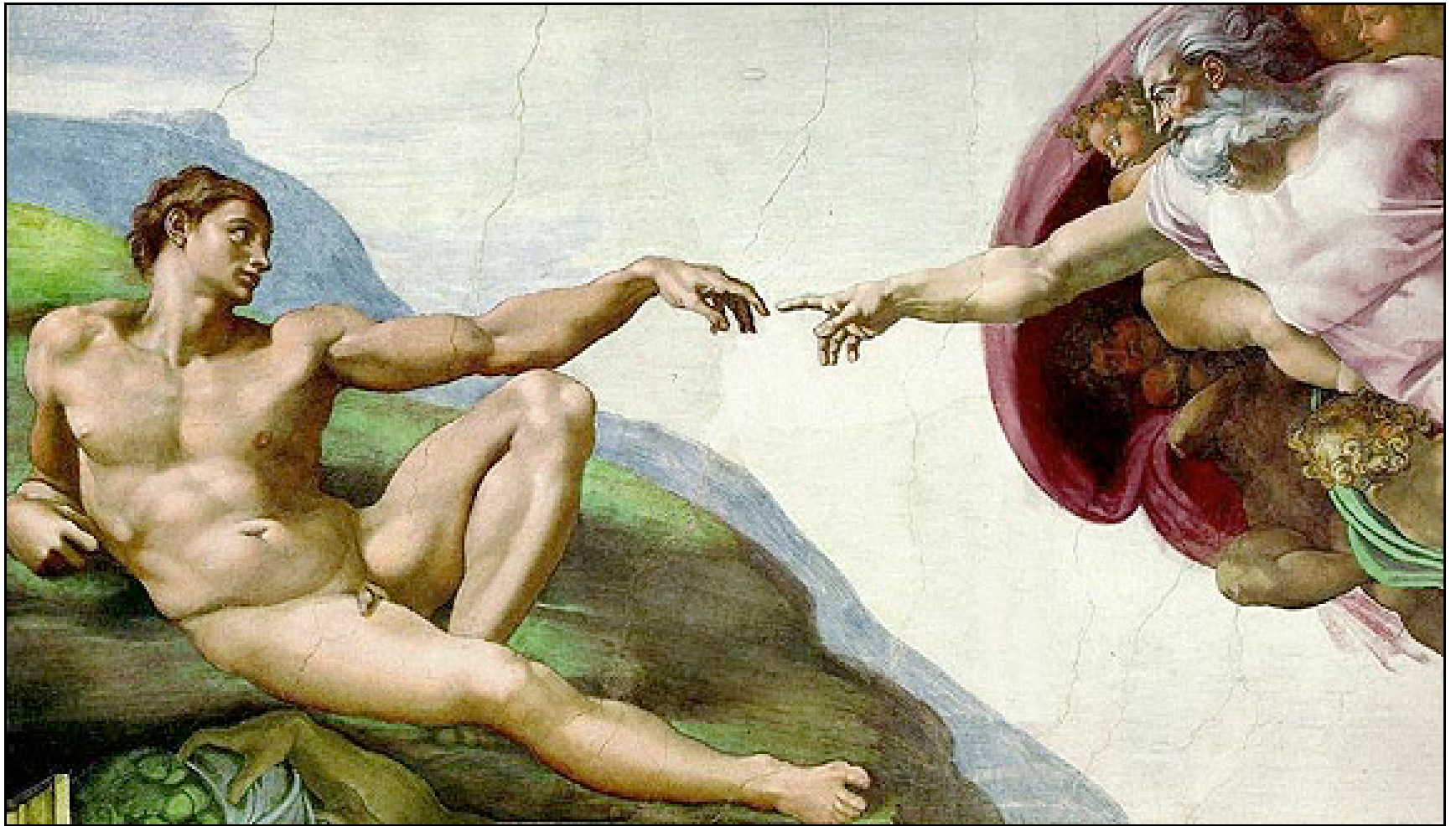


Stained-glass effect

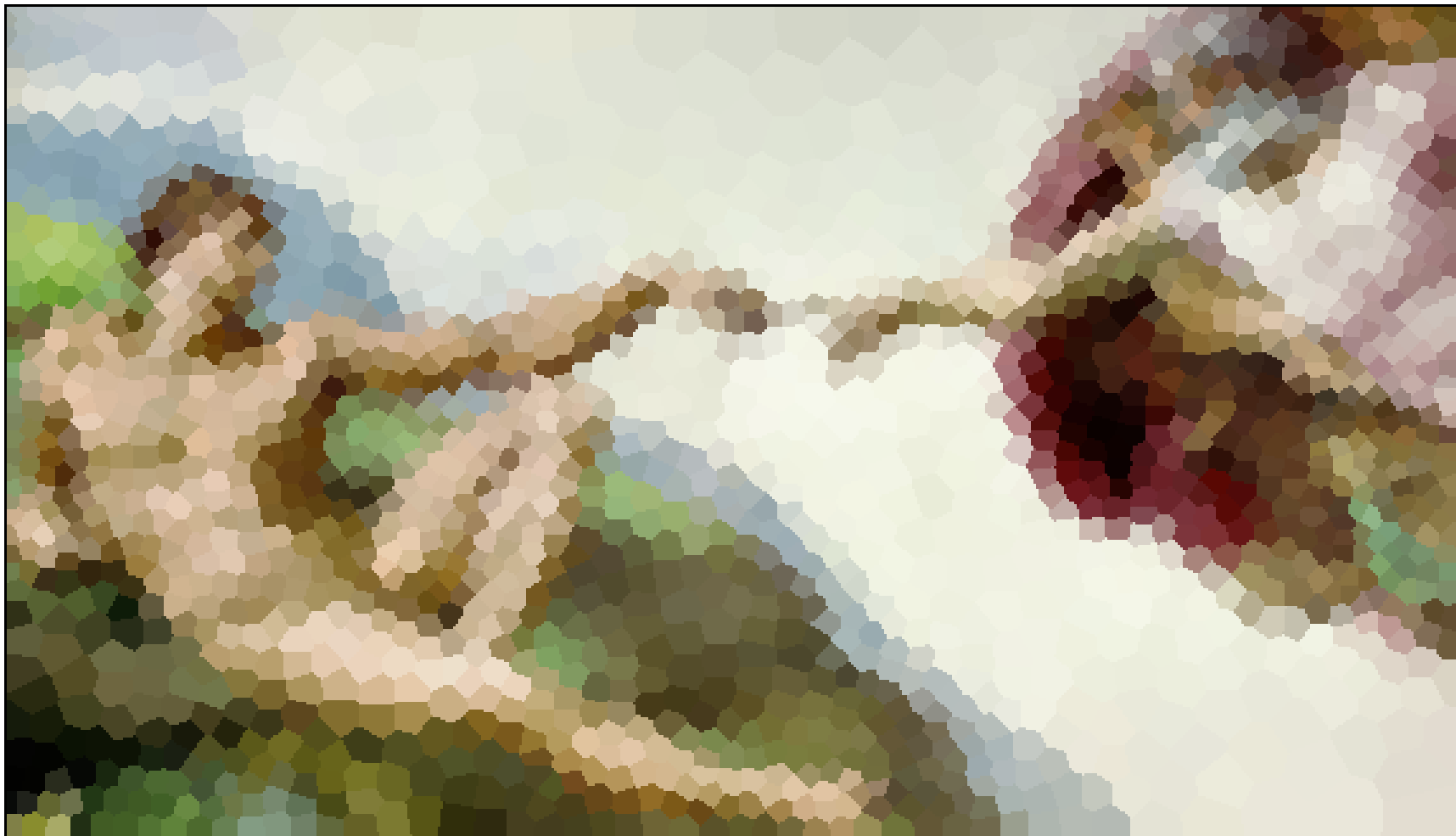




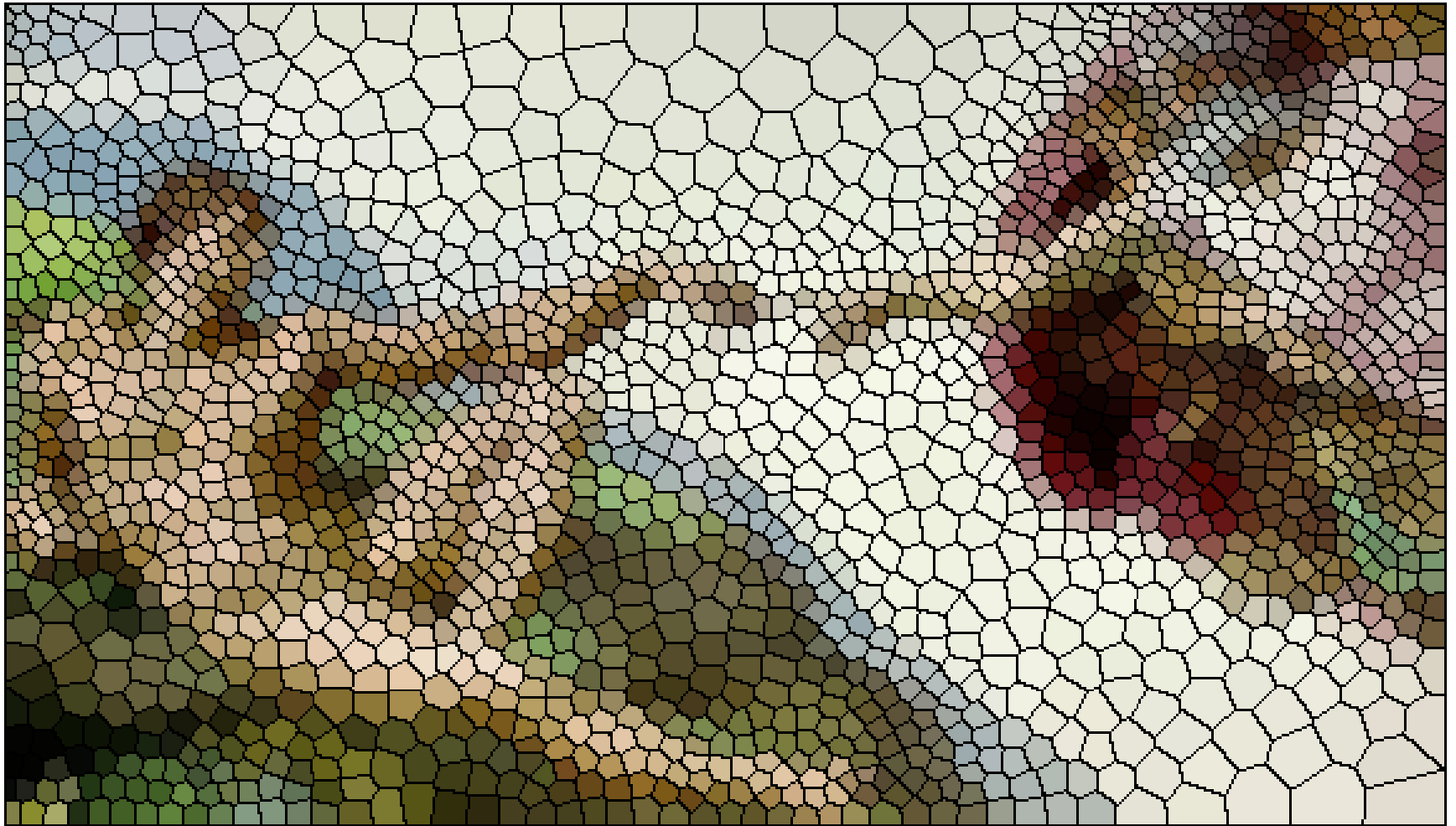
Quilt effect



Original image

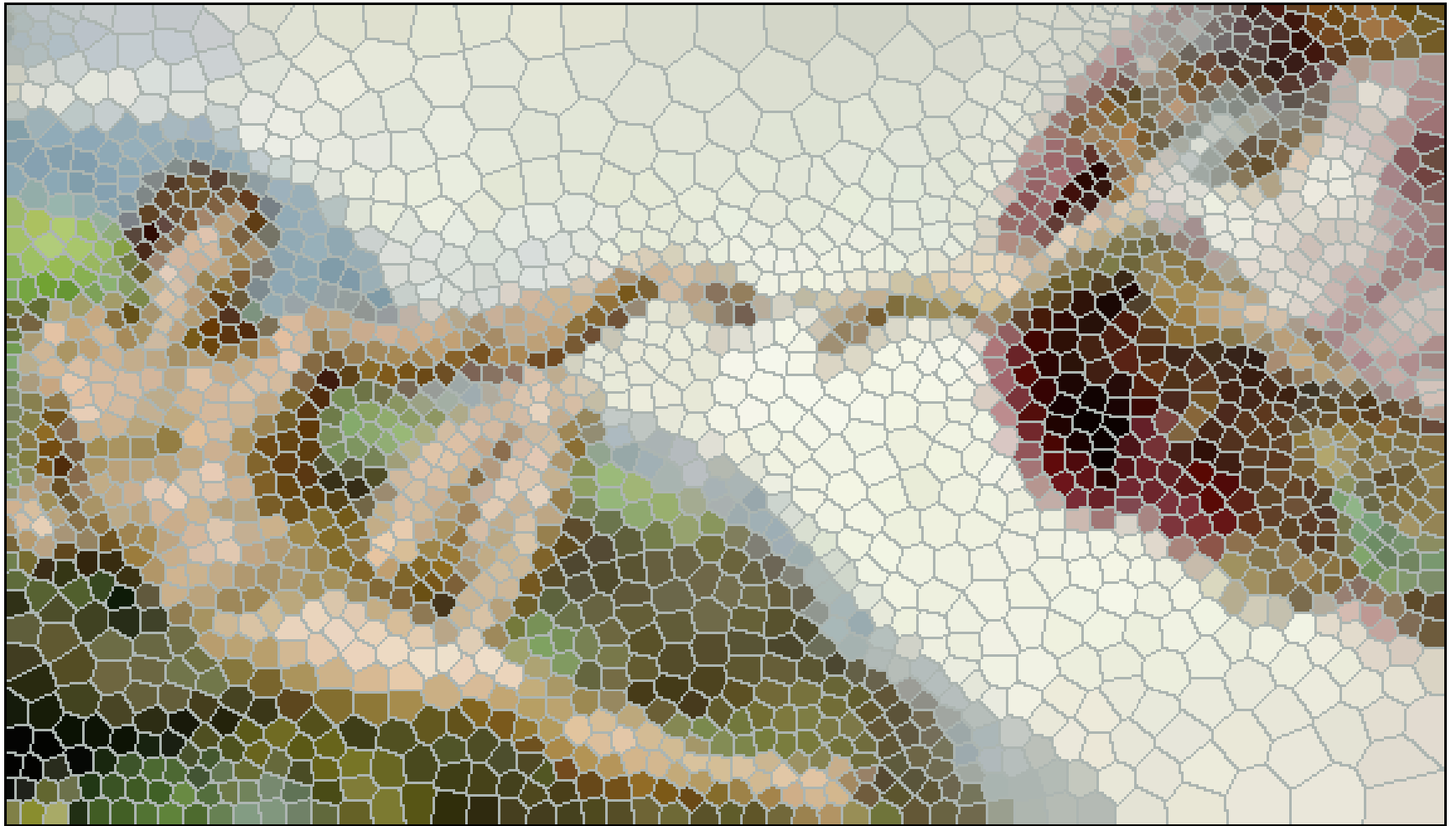


Painting effect



Mosaic effect





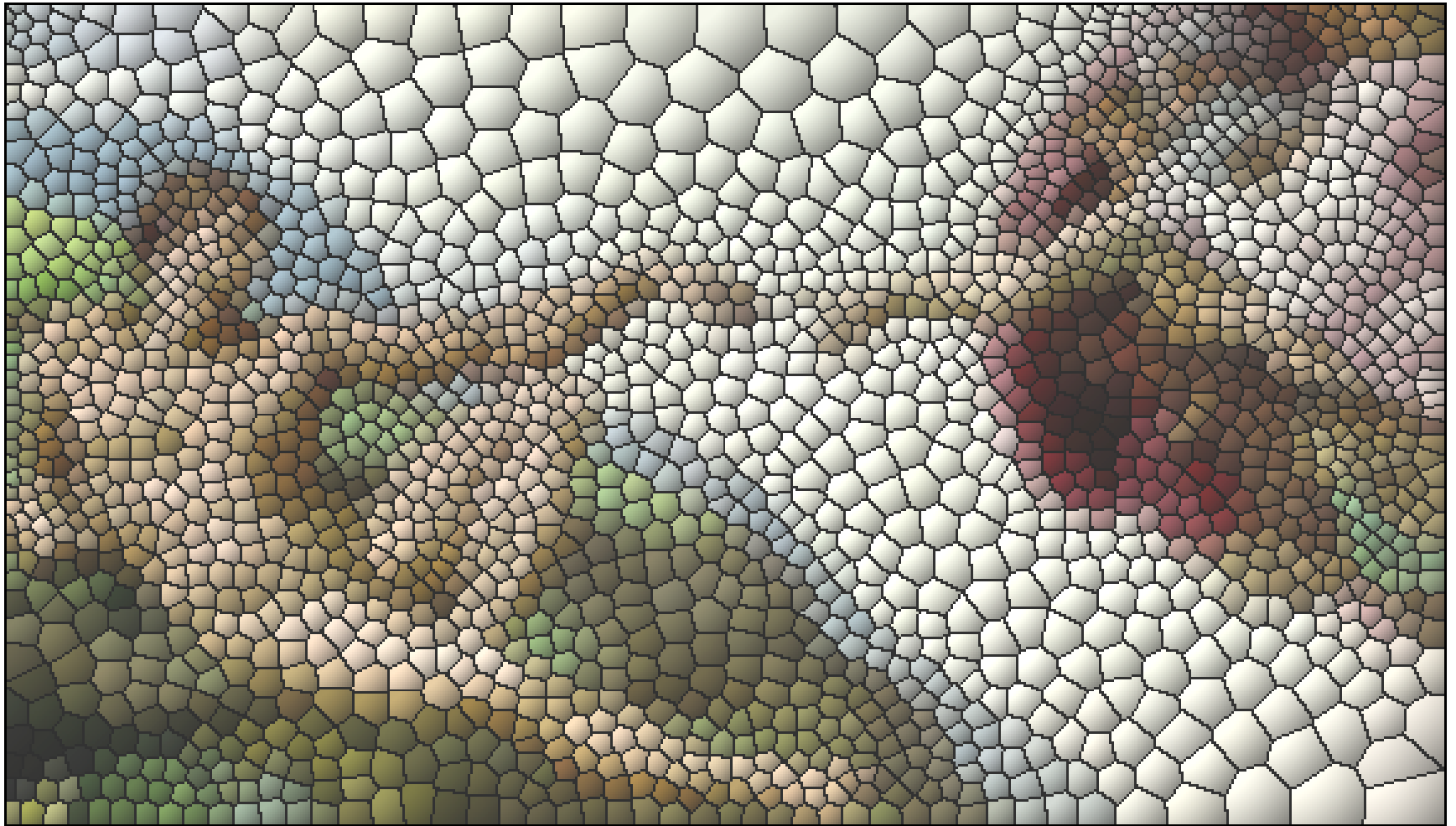
Mosaic effect



Stained-glass effect



Stained-glass effect

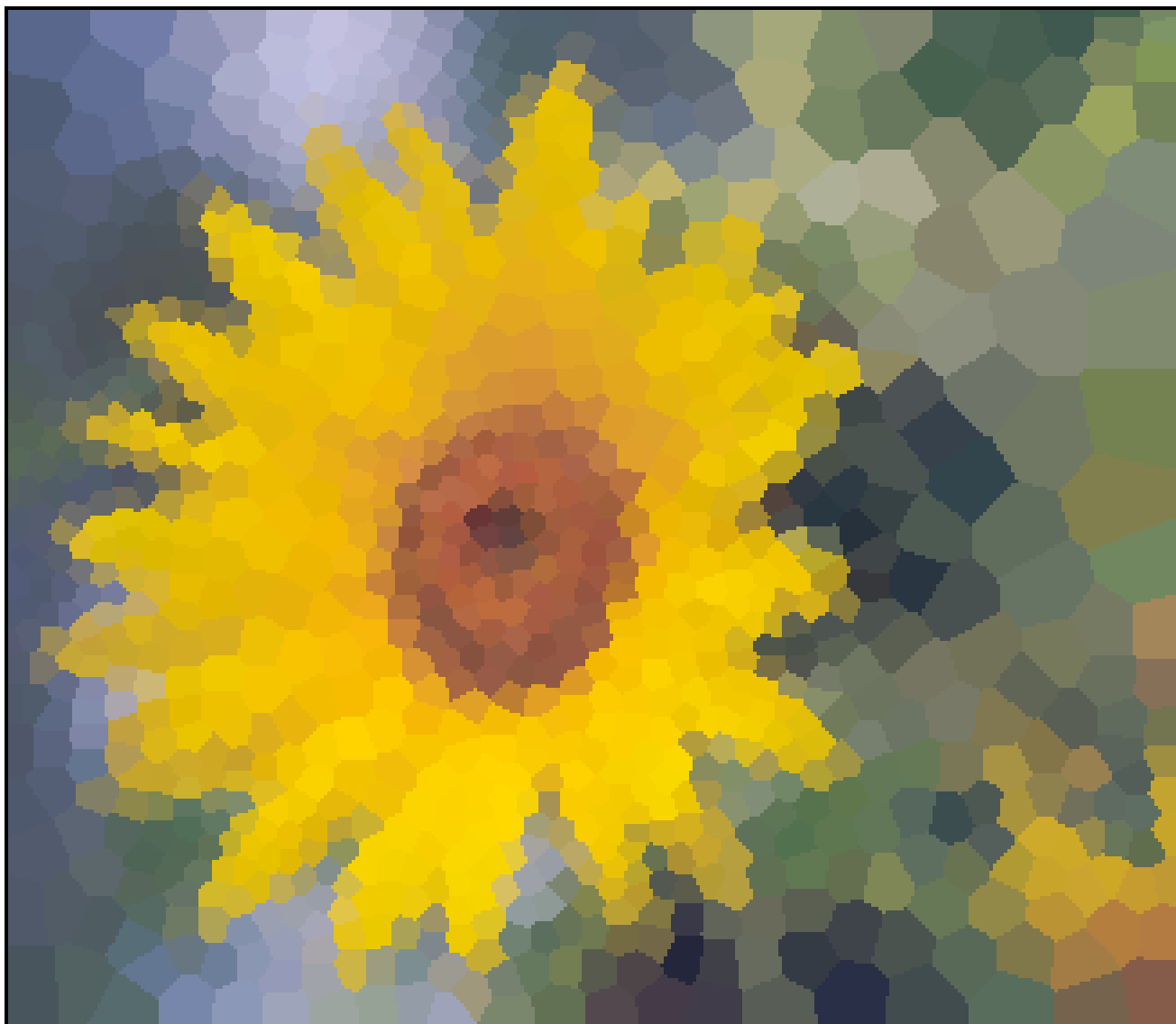


Quilt effect

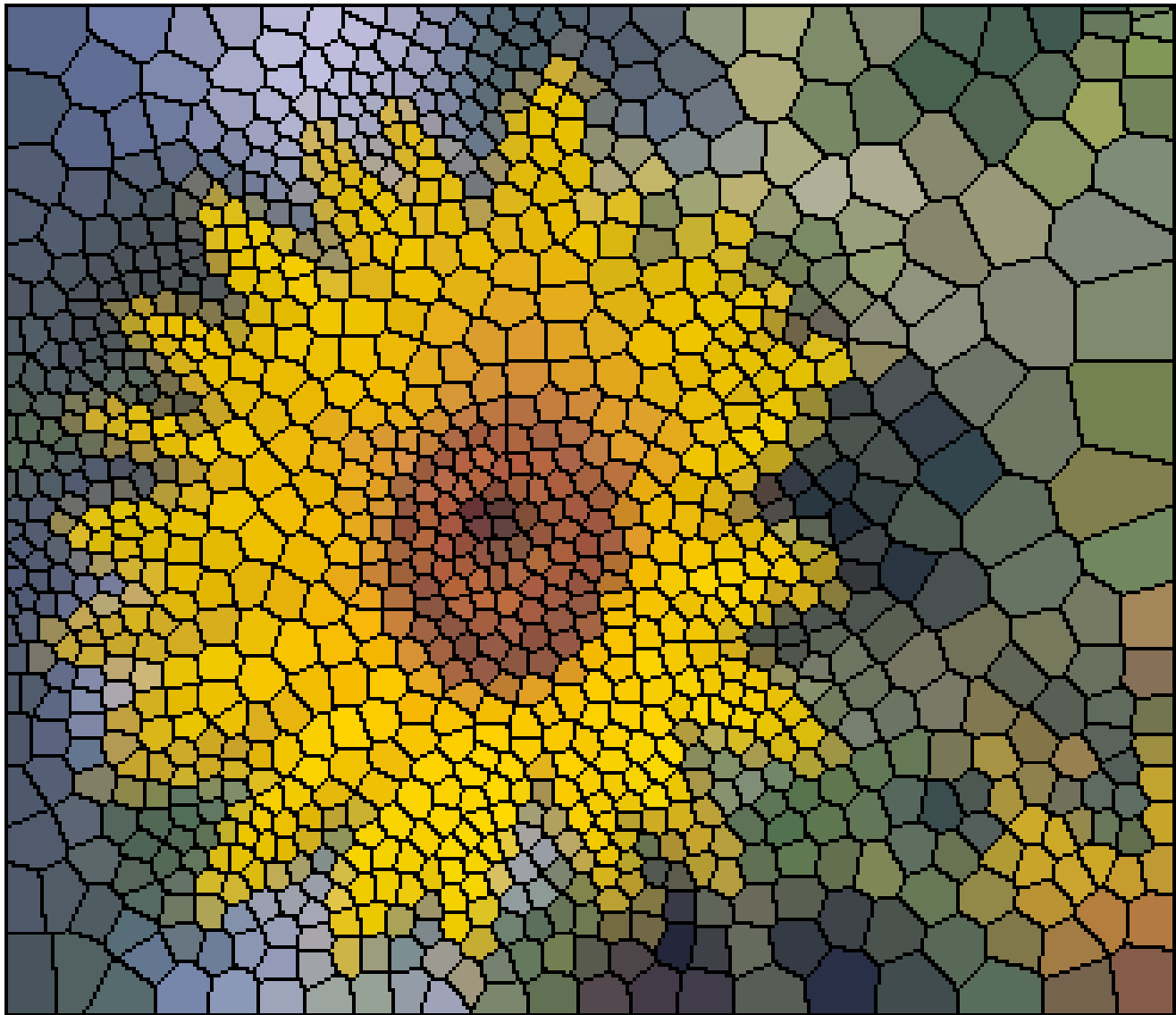




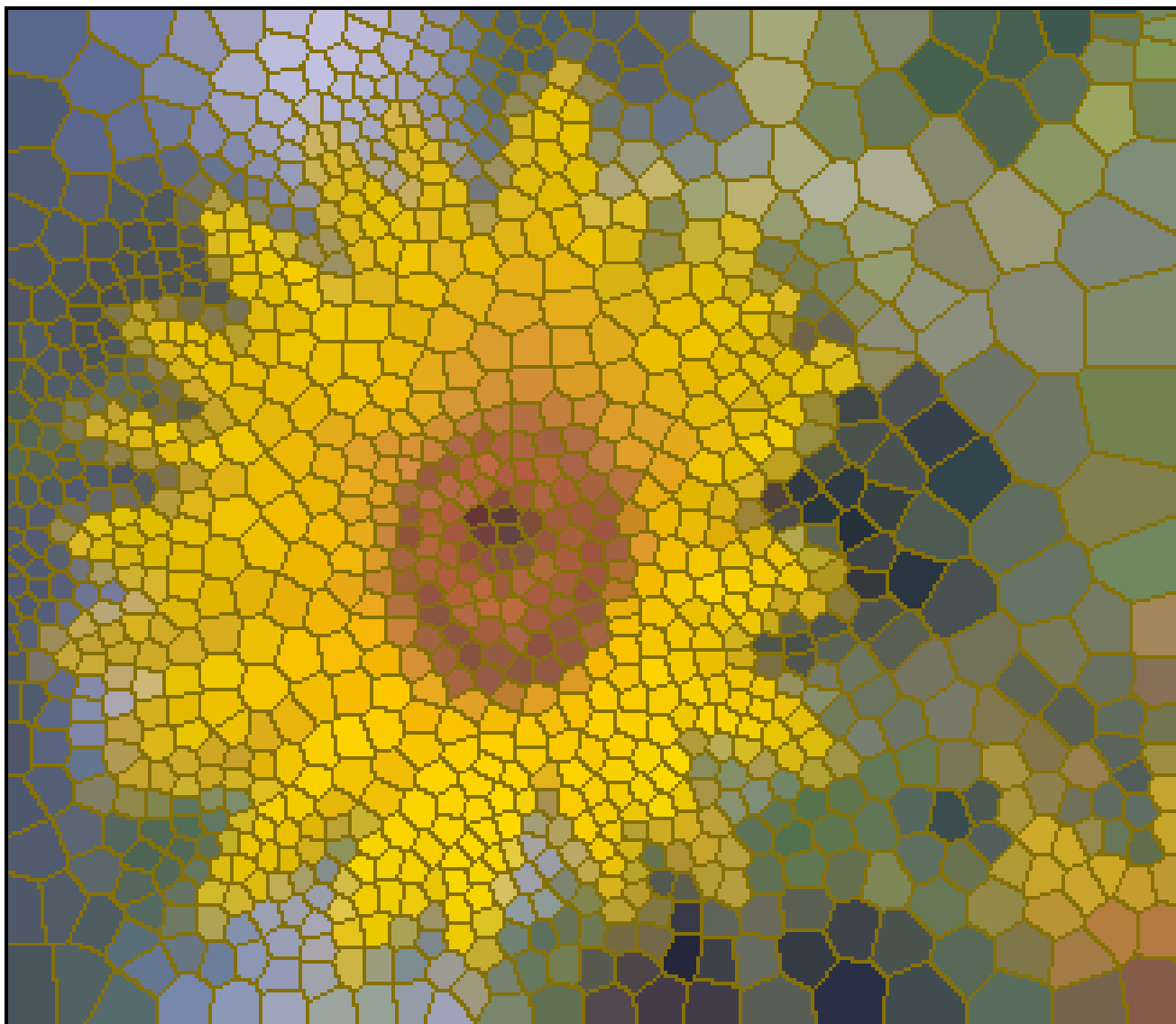
Original image



Painting effect



Mosaic effect

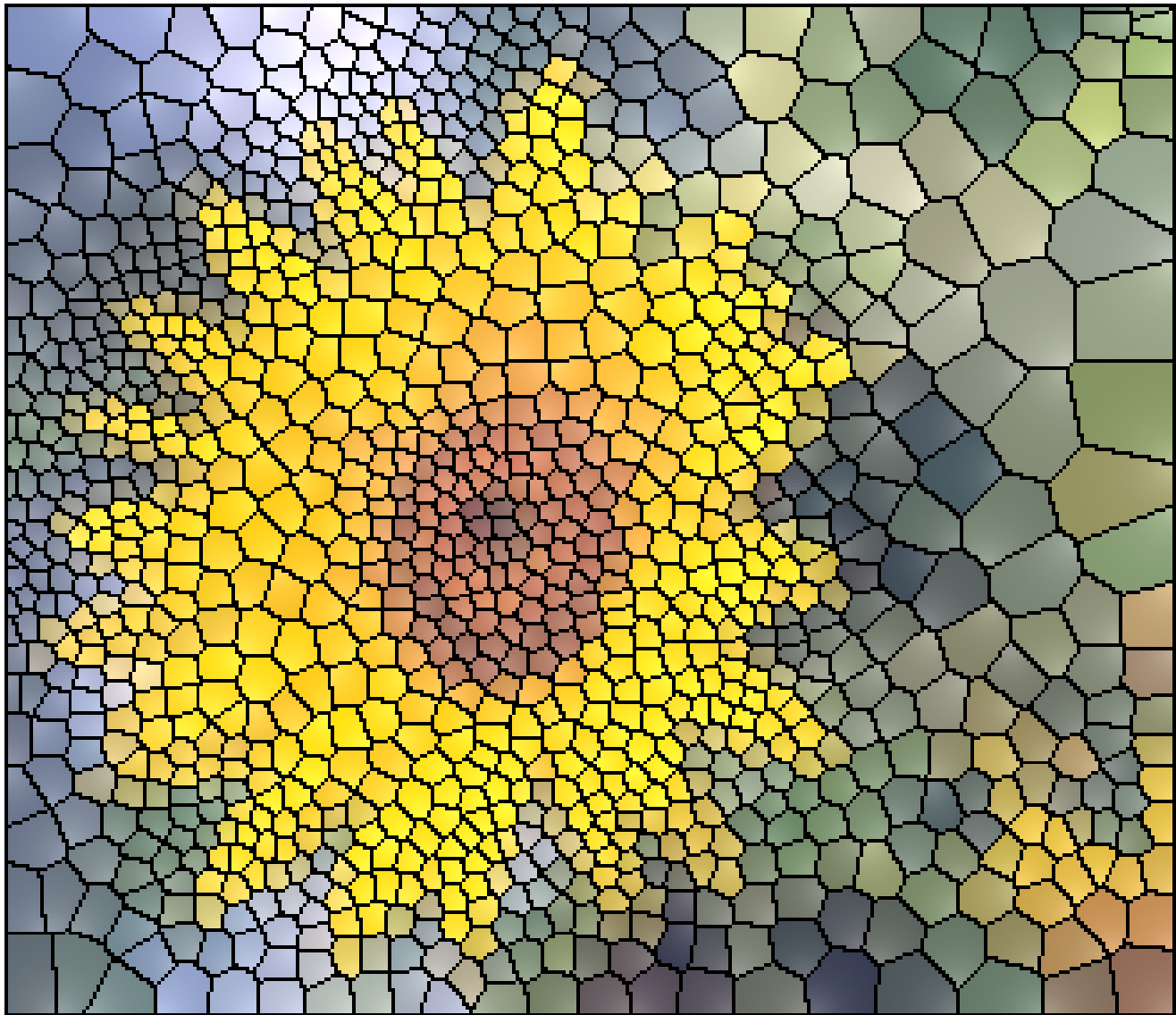


Mosaic effect

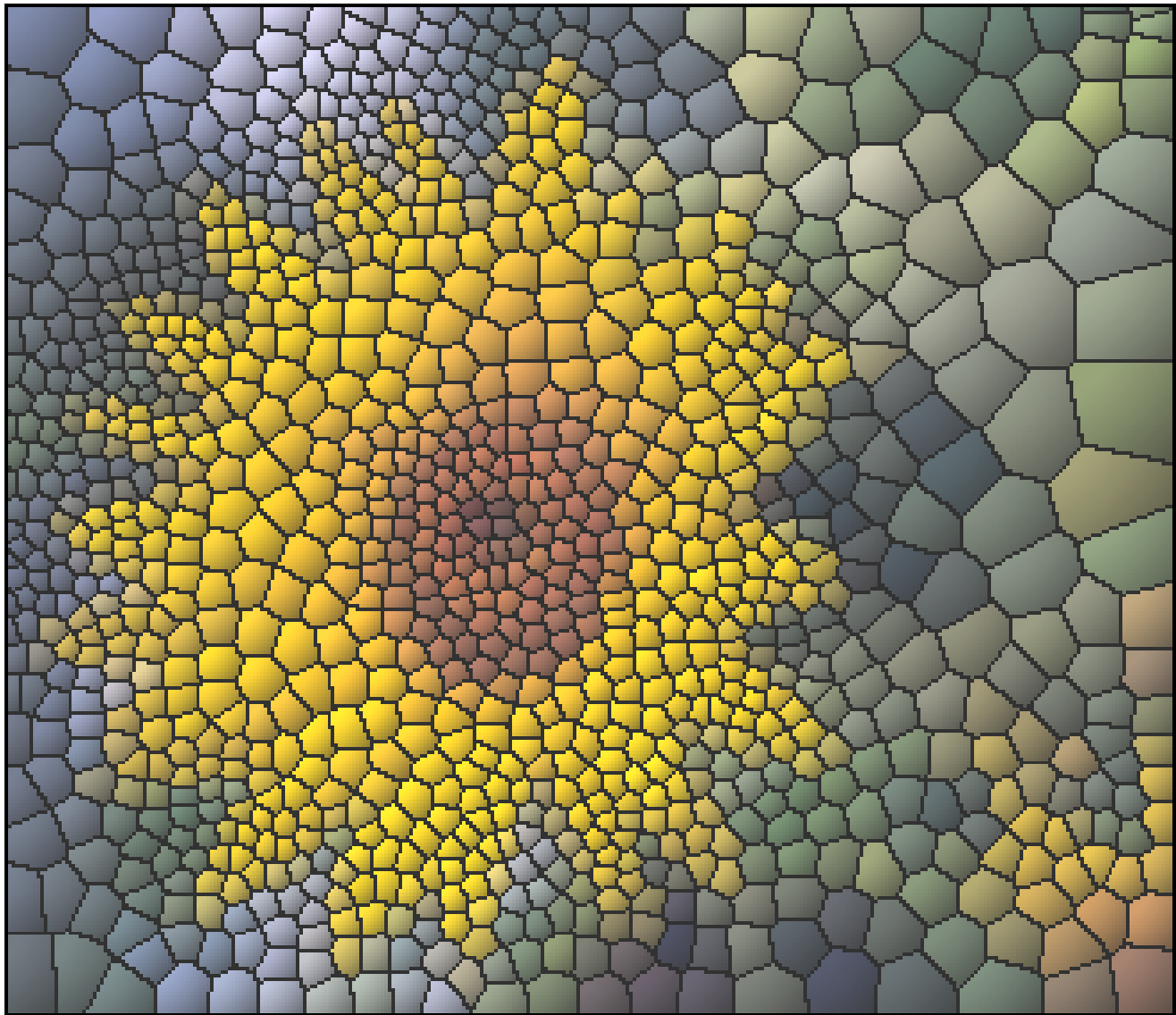




Stained-glass effect

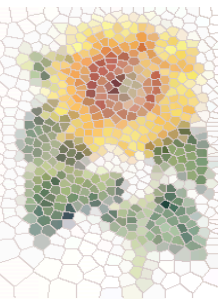


Stained-glass effect



Quilt effect

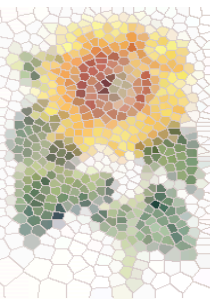
# Conclusion



## Our algorithm

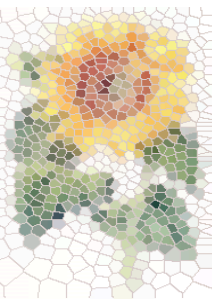
- ✓ is simple to implement
- ✓ produces locally adaptive mosaics that look nice
- ✓ needs little user intervention
- ✓ does not need special hardware

# Future work



- ✓ test other sampling strategies
- ✓ test other density functions
- ✓ reduce blur effect near edges





**The End**