

# Geometric design by principles and random sampling

Luis Alvarez and Jean-Michel Morel



Cueva de las manos, Argentina , 9.000 years ago



# Formalization of the Prehistoric Composition

- Choice of basic shapes used to create the composition.



We use Delaunay triangulation to manage shapes



# New shape generation using geometric transform and composition rules



Random Euclidean transformation with exclusion principle

# Colour assignment

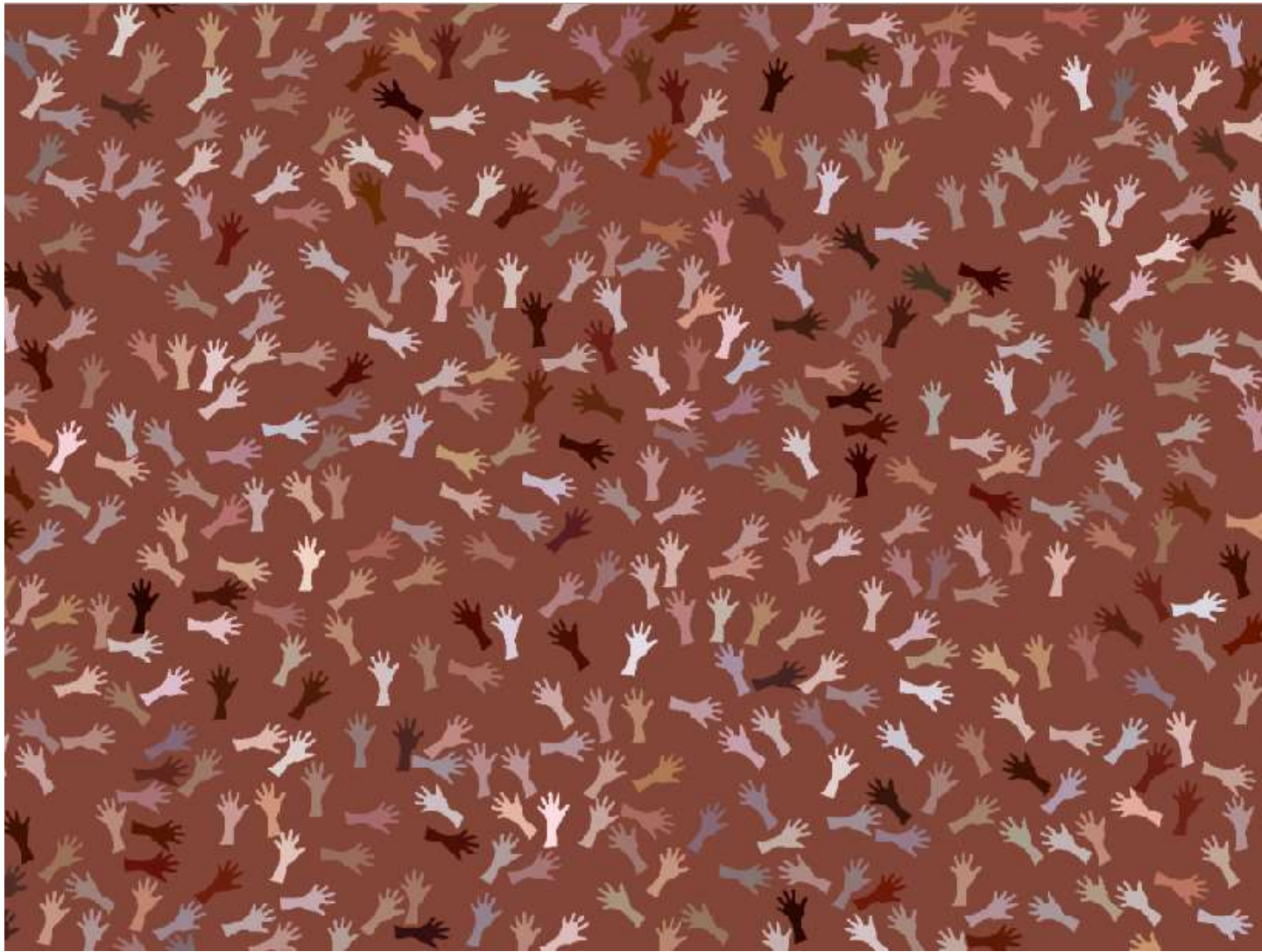


Color Palette



Simulation





Random Euclidean transformation with exclusion principle  
changing the shape size



Euclidean transformation with exclusion principle and a one given shape orientation





Euclidean transformation with exclusion principle and a two shape orientations



Euclidean transformation with exclusion principle and one vanishing point

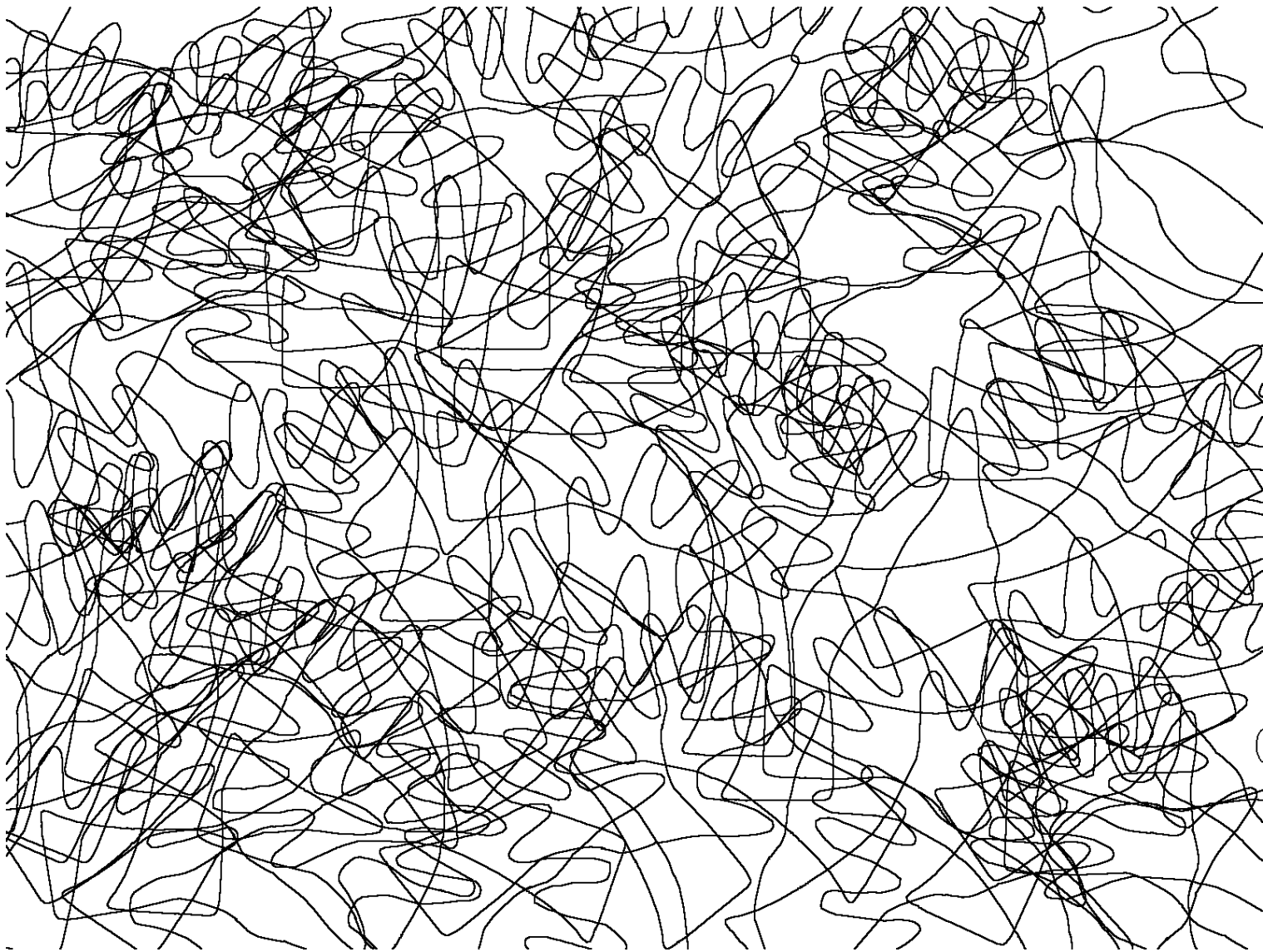


Random Euclidean transformation with occlusion principle





Random Euclidean transformation with occlusion principle and transparency.



Tessellation : Image domain partition using random Euclidean transformation with occlusion principle



Tessellation rendering : Different colors are associated to each connected component of the tessellation.





Tessellation rendering with a large number of shapes.





Tessellation rendering with a large number of shapes.





Tessellation rendering with a large number of shapes.



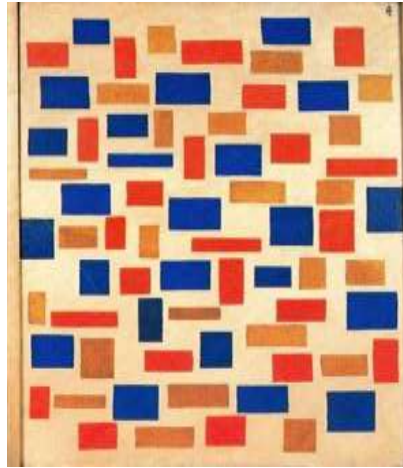
# Abstract geometric designs created by leading painters



Malevich



Malevich



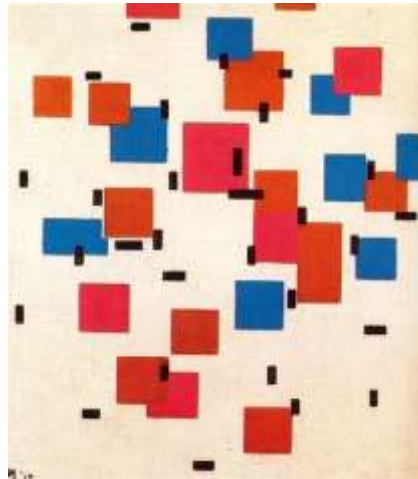
Van Doesburg



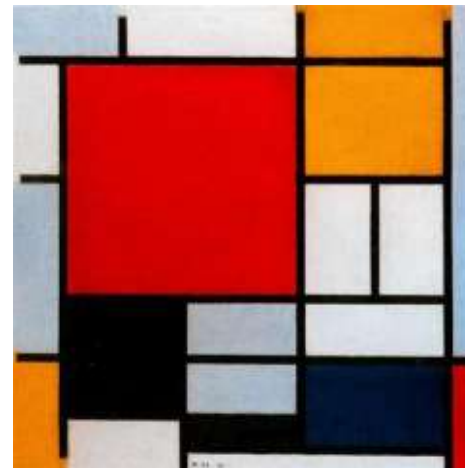
Buchheister



Kandisky



Mondrian

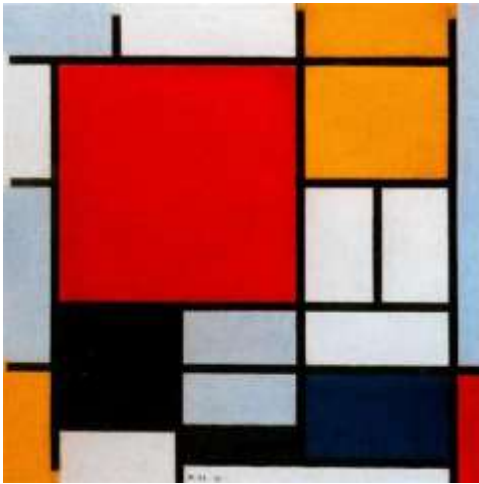


Mondrian



Arp

# Piet Mondrian (1921) Composition with Large Red Plane, Yellow, Black, Gray and Blue



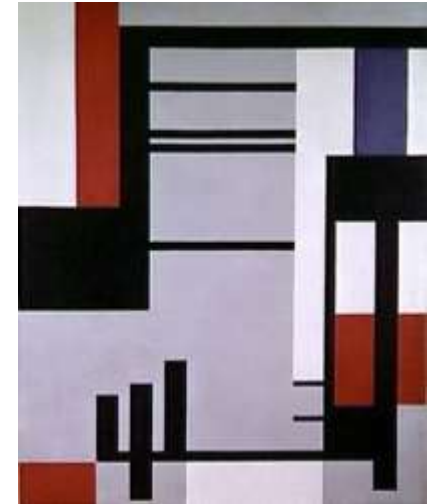
Mondrian 1921



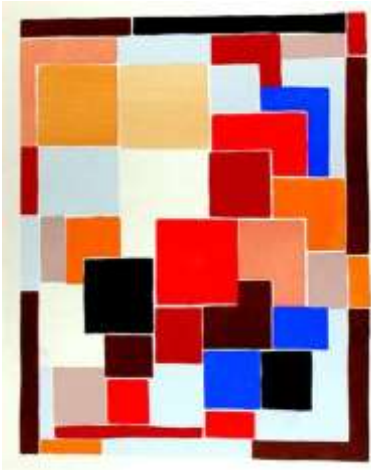
van Doesburg



Seuphor, 1929



Helion 1930



Sonia Delaunay, 1931  
Design in the style of Mondrian



Leger 1924



Torres 1929



Domela 1926



Jean Arp 1917. Collage with Squares Arranged According to the Laws of Chance.

What is the Law of Chance?

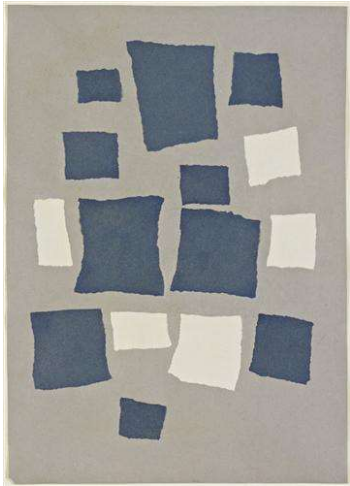
Arp writes : “the law of chance *can only be experienced through complete devotion to the unconscious*”. “Using this process ‘according to the law of chance’, isn’t per se, using chance.” “ *I further developed the collage by arranging the pieces automatically, without will.*” “We do not want to copy nature. We do not want to reproduce, we want to produce”.

“I wanted to find another order, another value of man in nature. I wanted to create new appearances, extract of man new forms”

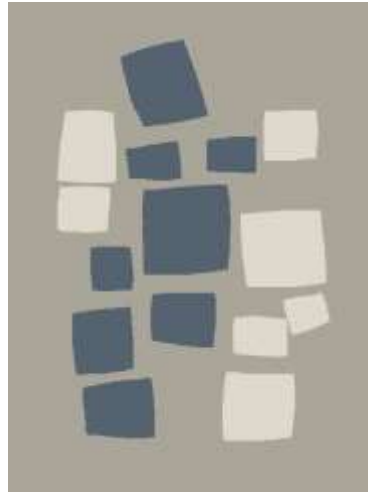


# Jean Arp (1917)

## Collage with Squares Arranged According to the Laws of Chance



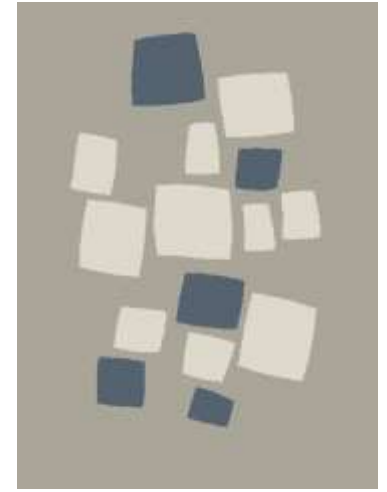
Original



Simulation 1



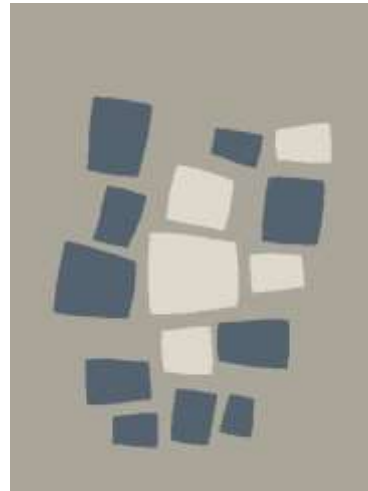
Simulation 2



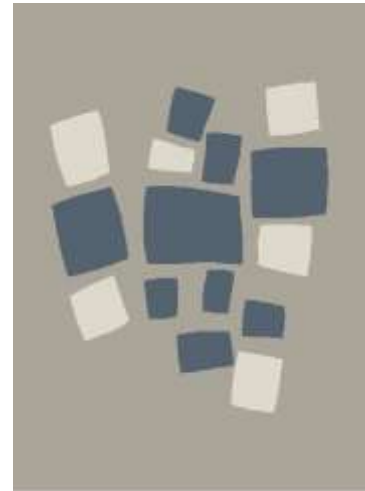
Simulation 3



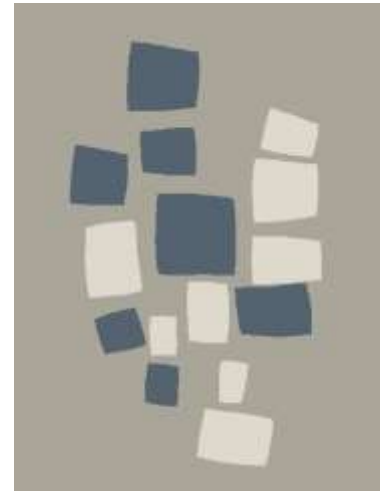
Simulation 4



Simulation 5



Simulation 6



Simulation 7

# Jean Arp (1917)

## Collage with Squares Arranged According to the Laws of Chance



Original



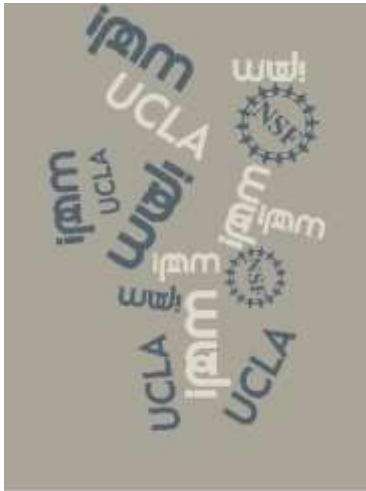
Simulation 1



Simulation 2



Simulation 3



Simulation 4



Simulation 5



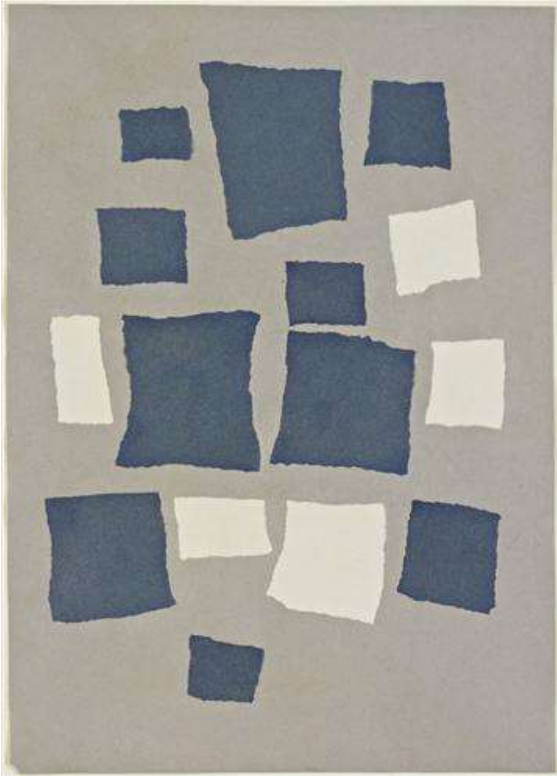
Simulation 6



Simulation 7



# Nonlinear deformation



Jean Arp 1917. Collage with Squares  
Arranged According to the Laws of Chance



Wassily Kandinsky 1913 . Color Study:  
Squares with Concentric Circles

# Nonlinear deformation transforms

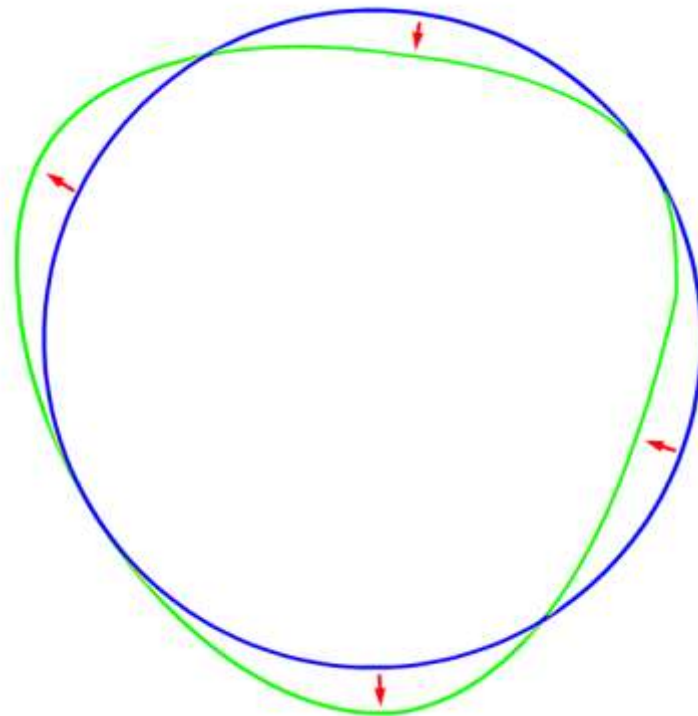
Let  $(x, y) \in \mathbb{R}^2$  and  $(x_c, y_c)$  the deformation center. We define the following transformation

$$\varphi = \text{atan2}(y - y_c, x - x_c)$$

$$\varphi' = \varphi_0 + k_0 \beta_0(\varphi)$$

$$\begin{pmatrix} x_c \\ y_c \end{pmatrix} + \begin{pmatrix} \cos(\varphi') & -\sin(\varphi') \\ \sin(\varphi') & \cos(\varphi') \end{pmatrix} \begin{pmatrix} 1 & 0 \\ 0 & 1 - k_1 \beta_1(\varphi - \varphi_1) \end{pmatrix} \begin{pmatrix} \cos(\varphi') & \sin(\varphi') \\ -\sin(\varphi') & \cos(\varphi') \end{pmatrix} \begin{pmatrix} x - x_c \\ y - y_c \end{pmatrix}$$

where  $k_0, k_1 \geq 0$ ,  $\varphi_0, \varphi_1 \in [0, 2\pi]$ ,  $\beta_0, \beta_1 \in W^{1,\infty}(\mathbb{R})$  are  $2\pi$  periodic functions.

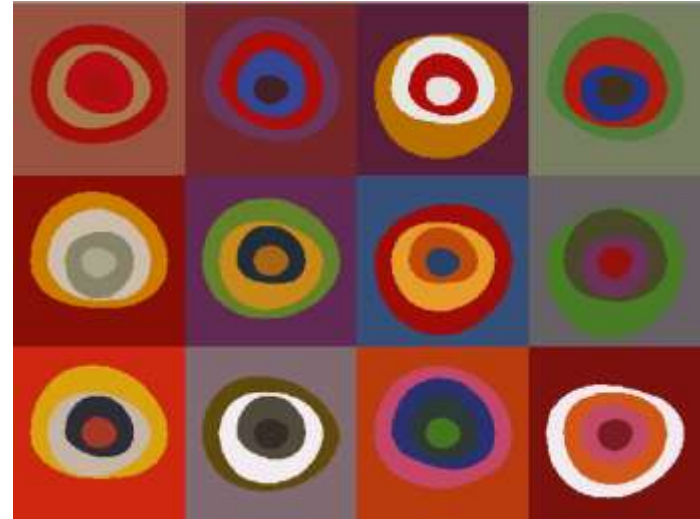




# Wassily Kandinsky 1913 . Color Study: Squares with Concentric Circles



Original



Simulation 1



Simulation 2



Simulation 3

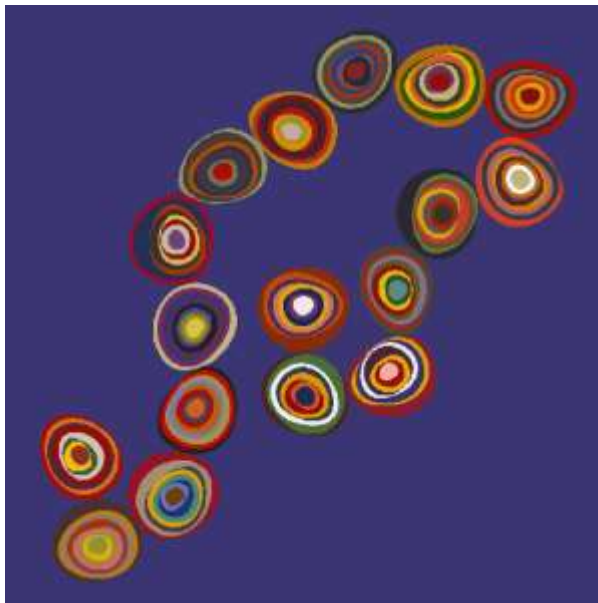
# Wassily Kandinsky 1913 . Color Study: Squares with Concentric Circles



Original



Simulation 1



Simulation 2



Simulation 3



# Shape generation



Wassily Kandinsky 1937. Thirty



# Henri Matisse (1952) The Parakeet and the Mermaid.



Original



Simulation 1



Simulation 2



Simulation 3

# Collaboration with the professional painter José Antonio García





# Symmetry and Periodicity



Rossete (Egypt)



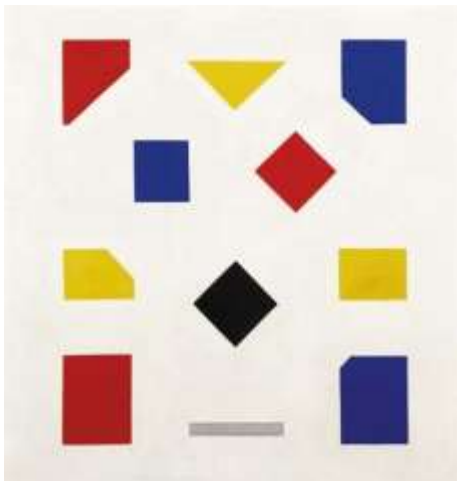
Mandala (Tibet)



Persian carpet



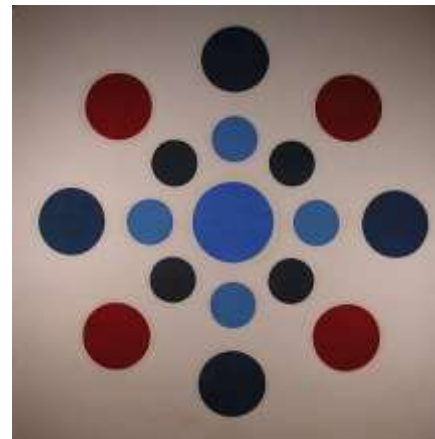
Baschet (Hermes)



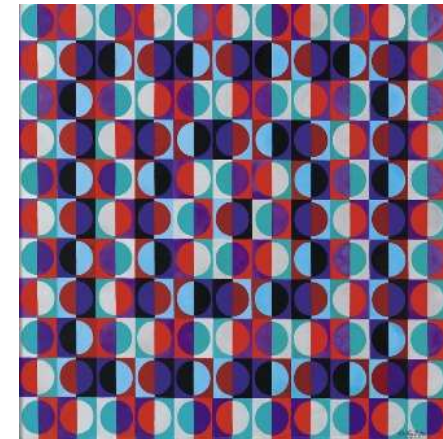
Van der Leck



Daphnis



Downing



Boto



# Weak Symmetry versus Strong Symmetry



Catherine Baschet (Hermes Silk Twill Scarf)



Simulation of 45° strong symmetry



# Designs inspired in Persian Carpets



Simulation 1



Simulation 2



# Designs inspired in Persian Carpets



Simulation 1



Simulation 2



# Designs inspired in Persian Carpets



Simulation 1



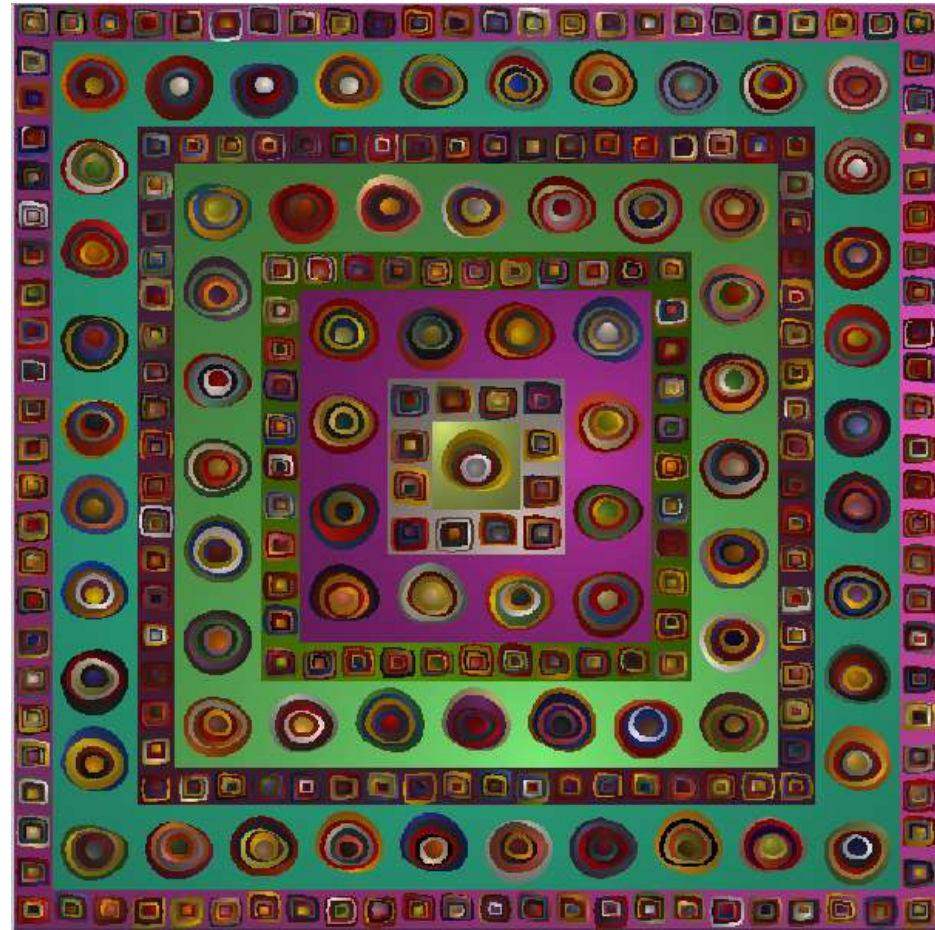
Simulation 2



# Designs inspired in Persian Carpets and Kandisky circles



Simulation 1



Simulation 2



# Shape connectivity



Gustav Klimt, 1909, The Tree of Life



Simulation 1



Simulation 2



Simulation 3



# Shape connectivity



Simulation 1



Simulation 2



Simulation 3



Simulation 4

# Tessellations



Freundlich



Klee



Robert Delaunay



Torres García



Ackerman



Asis



Gray



Gray



# Tessellations



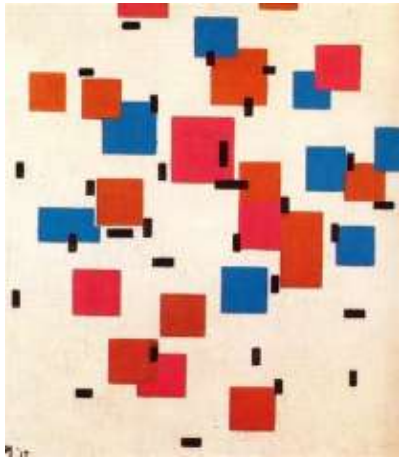
Simulation 1



Simulation 2



# A Multilayer Approach to Geometric design



Mondrian



Kandisky



Matisse



Alechinsky



Goodnough



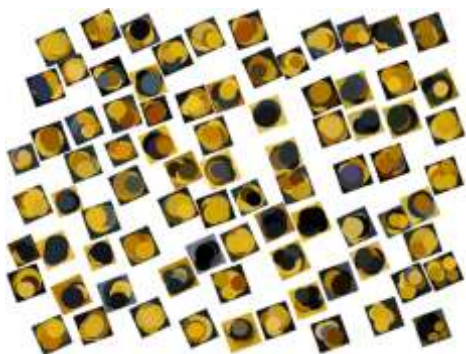
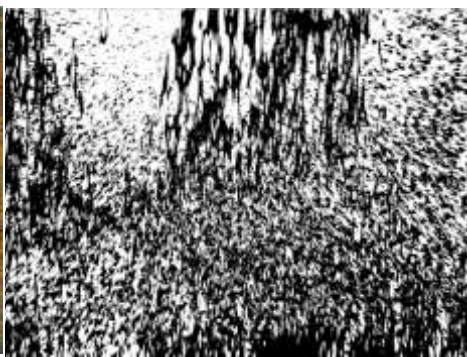
Barbeau



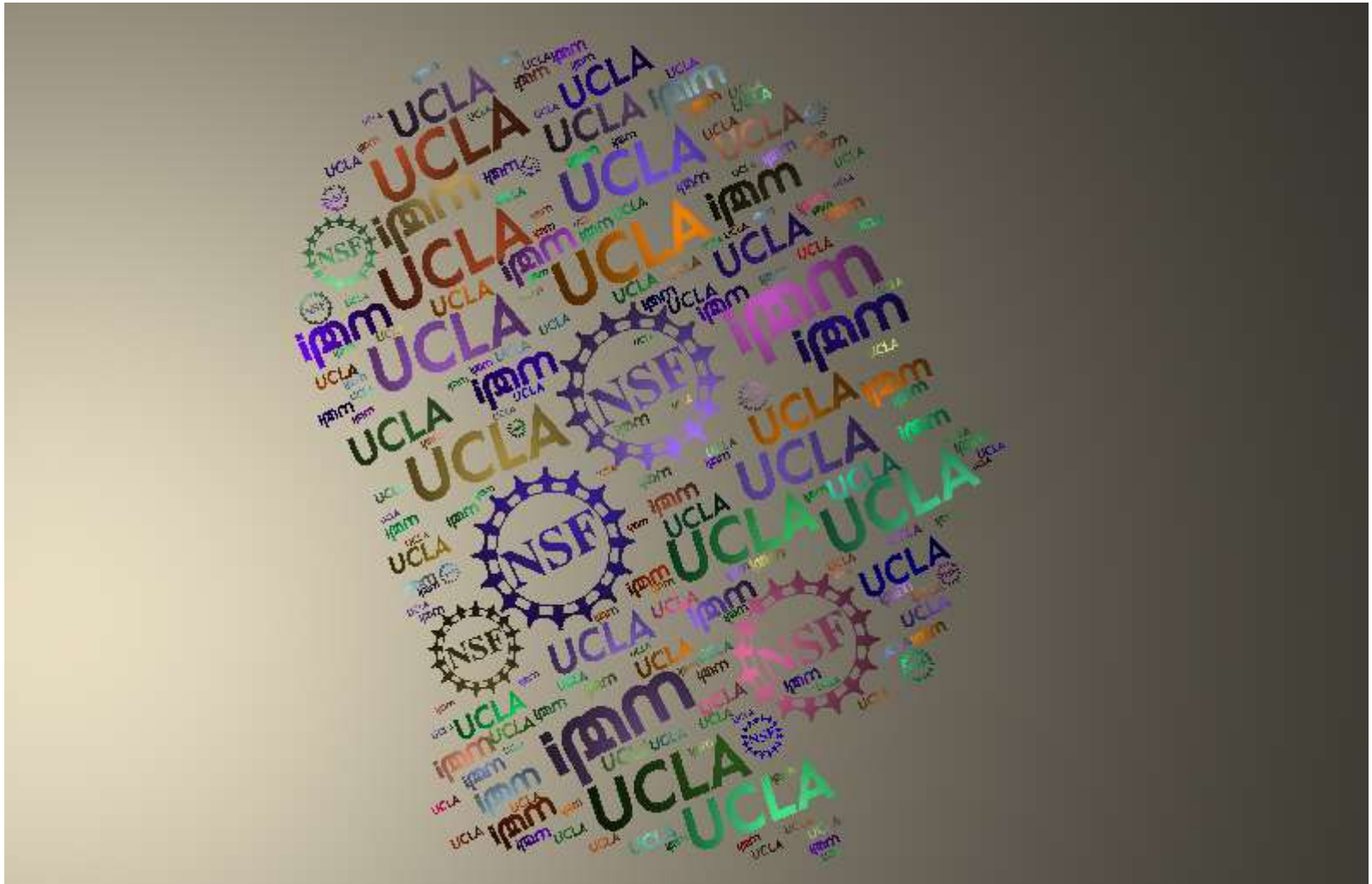
Pollock



# A Multilayer Approach to Geometric design



**!! THANK YOU !!**



<http://www.ctim.es/ImageSynthesis/>