

Automated Recoloring of Evolved Designs using Evolved Palettes

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Outline.

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- III. The Color Look-Up Table.
- IV. The Evolved Palettes.
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I. Introduction.

- A.** By a “design” D we mean an abstract geometric image whose digital representation is an $N \times N$ array of pixels $(p_{i,j})$.
- B.** The design D is colored using a look-up table if the color $C(p)$ assigned to each pixel p is selected from a (small) set of colors $\{c_1, \dots, c_L\}$.
- C.** Look-up table colorings typically arise when images must be false colored, or pseudo-colored, because each pixel has a “density” $d(p)$ lying in the interval $[0, 1]$.
- D.** An index map $I : [0, 1] \longrightarrow \{1, \dots, L\}$ determines a false coloring by letting $C(p) = c_{I(d(p))}$.
- E.** We “recolor” D by first constructing a map

$$h : \{1, \dots, L\} \longrightarrow \{1, \dots, L\}$$

and then assigning color $c_{h(i)}$ to all pixels that are currently colored c_i .

II. The Evolved Designs.

A. Consider the prefix representation of a function

$$F : I \times I \longrightarrow I.$$

e.g., $F(V_0, V_1) = \max(\text{mul}(0.758, V_0), \text{sqrt}(V_1))$

B. Construct postfix tree using symbolic equivalents.

e.g., $F(V_0, V_1) = V_1 U_2 V_0 C_{758} B_0 B_6$

C. Define the density of pixel $p_{i,j}$ to be $d_{i,j} = F(i/N, j/N)$.

III. The Color Look-Up Table.

Our HSV table of size $L = 450$ has nine shades for each of fifty different hues. The index map to this HSV color look-up table is given by:

$p_{i,j} \in [0/450, 1/450)$	\longrightarrow	$(0.00, 0.70, 0.70)$
$p_{i,j} \in [1/450, 2/450)$	\longrightarrow	$(0.00, 0.70, 0.80)$
$p_{i,j} \in [2/450, 3/450)$	\longrightarrow	$(0.00, 0.70, 0.90)$
$p_{i,j} \in [3/450, 4/450)$	\longrightarrow	$(0.00, 0.80, 0.70)$
		.
		.
		.
$p_{i,j} \in [8/450, 9/450)$	\longrightarrow	$(0.00, 0.90, 0.90)$
$p_{i,j} \in [9/450, 10/450)$	\longrightarrow	$(0.12, 0.70, 0.70)$
		.
		.
		.

IV. The Evolved Palettes.

- A.** Representation — The recoloring map h is defined by the L -tuple $(h(1), h(2), \dots, h(L))$.
- B.** Initialization — A small number of “segments.”
- C.** Mating Operator— Two-point crossover.
- D.** Mutation Operators — extend segment, duplicate segment, insert color, extend color.

V. The Automation Process.

A. Color segment recolored “thumbnail” D_t .

B. Use multi-objective optimization. For example,

$$F_1(D_t) = A_{2,6} \cdot J_{13,25} + P_{4,5}$$

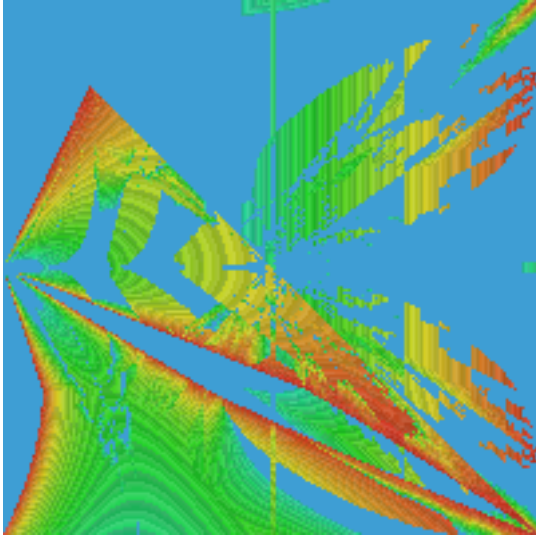
$$F_2(D_t) = \min(E_{1,4.2}, E_{2,3.7}) \cdot B_{1,4}$$

where A is weighted sum of areas, J is sum of adjacencies, B is sum of boundary lengths, P is complementarity measure, and E is target-color error.

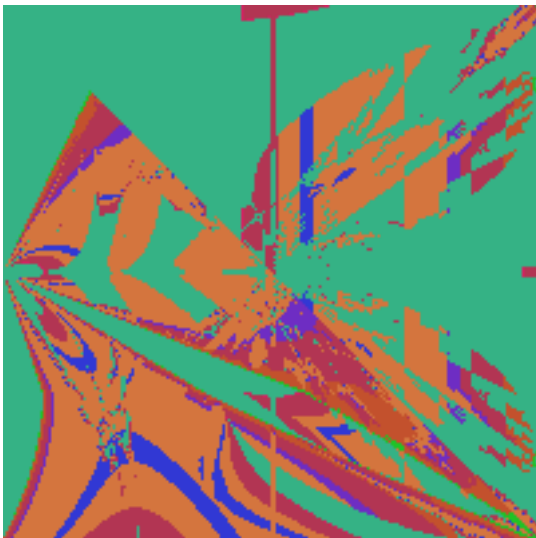
C. Hand select best images from the “leading front.”

VI. The Recolorings.

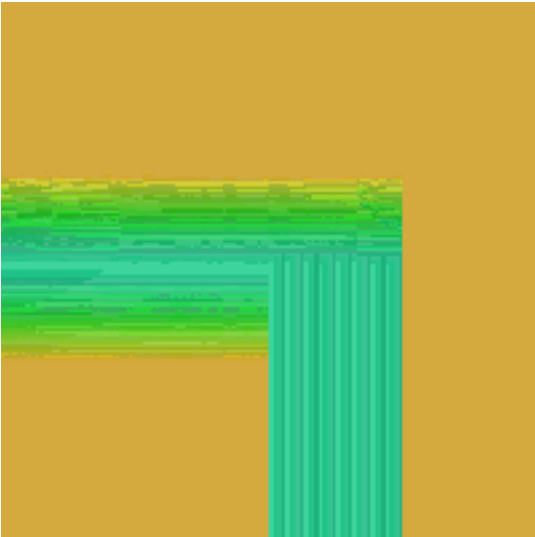
Original.



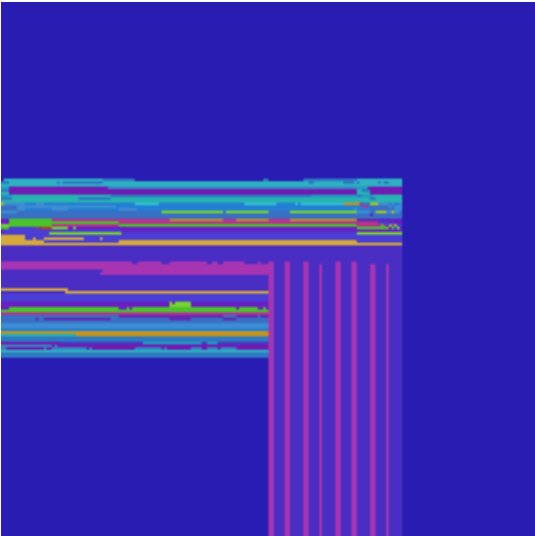
Best recoloring.



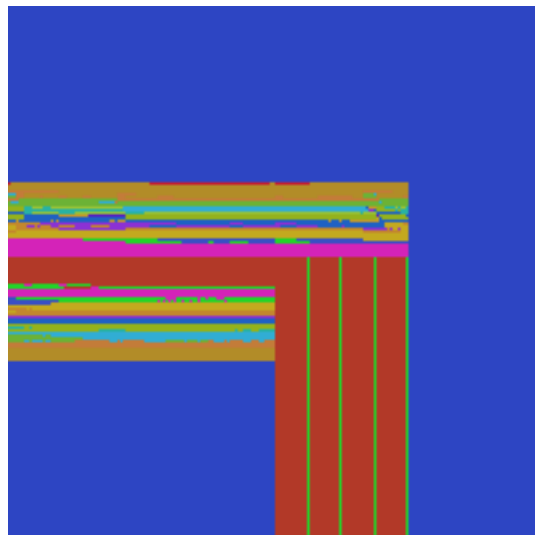
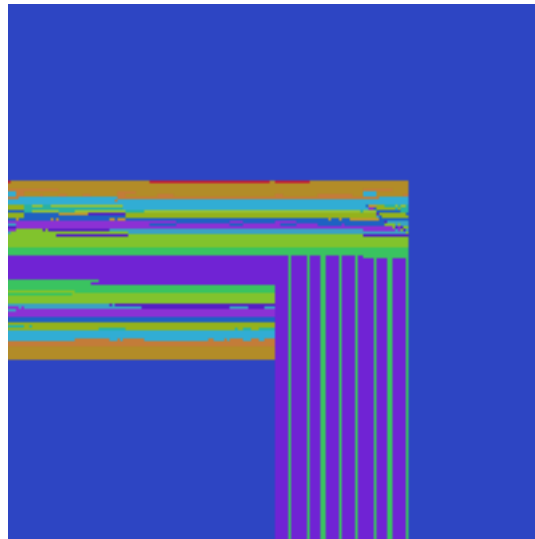
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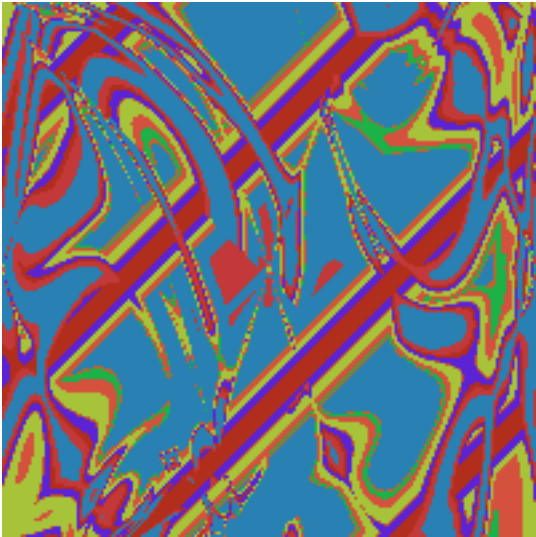
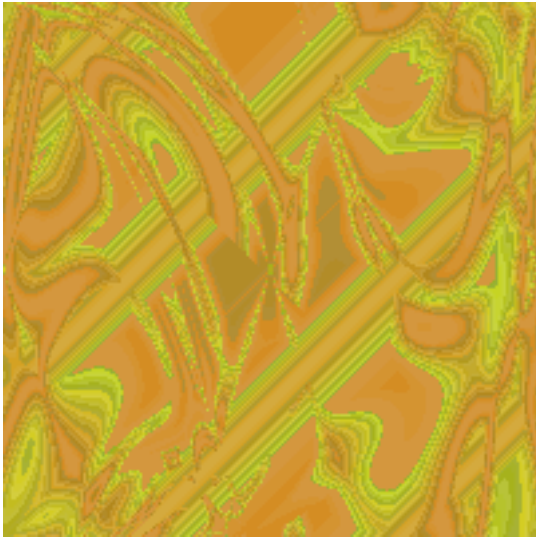
Best recoloring.



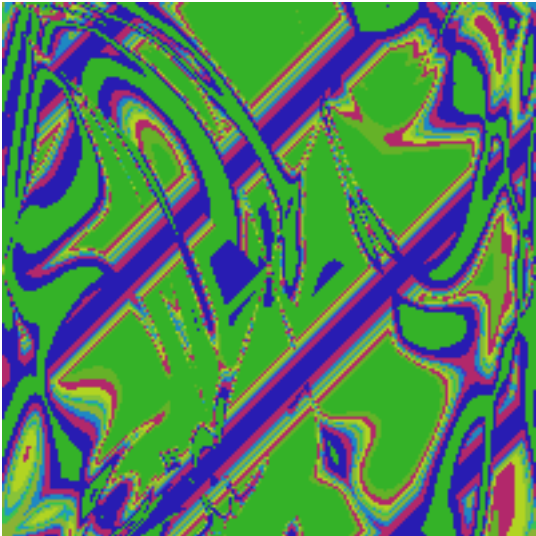
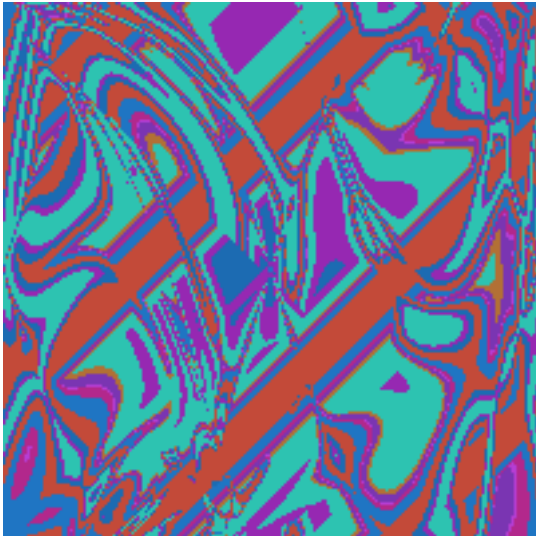
Two more recolorings.



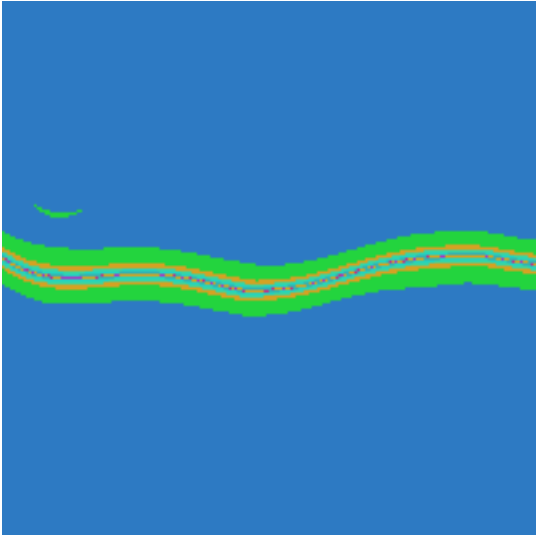
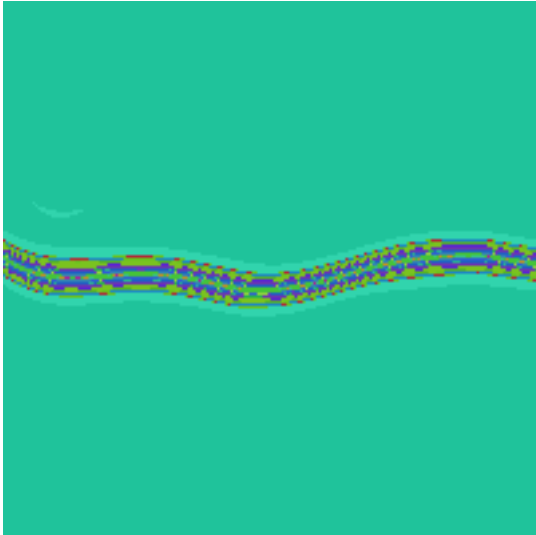
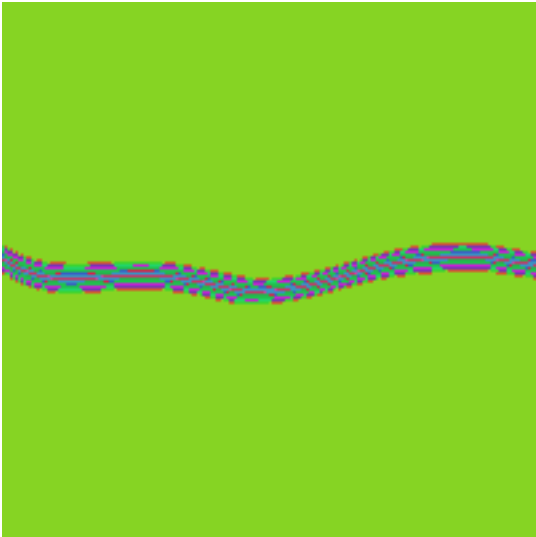
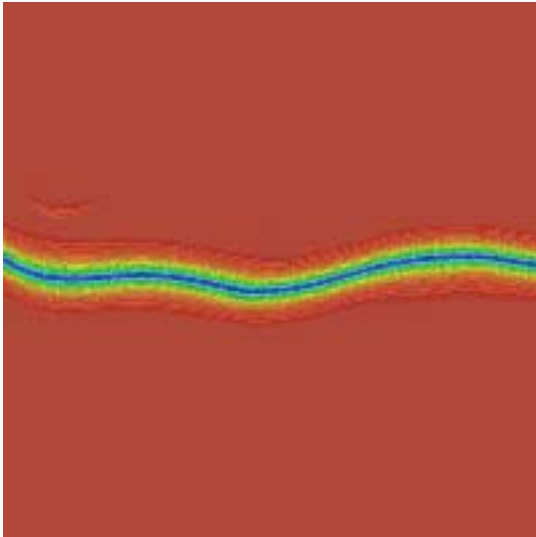
Original and best recoloring.



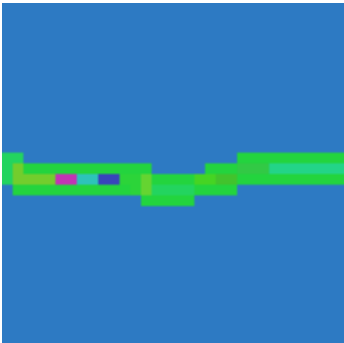
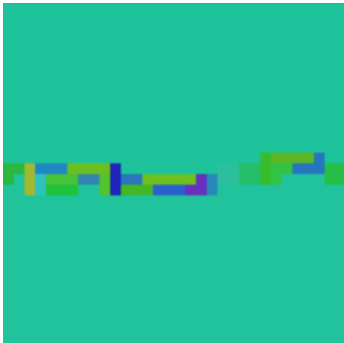
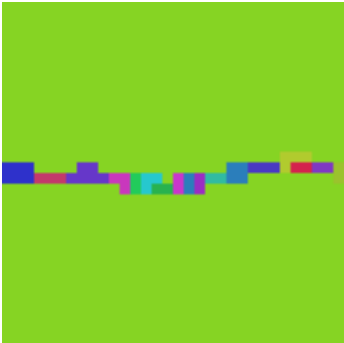
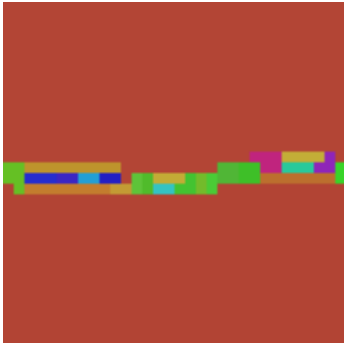
Two more recolorings.



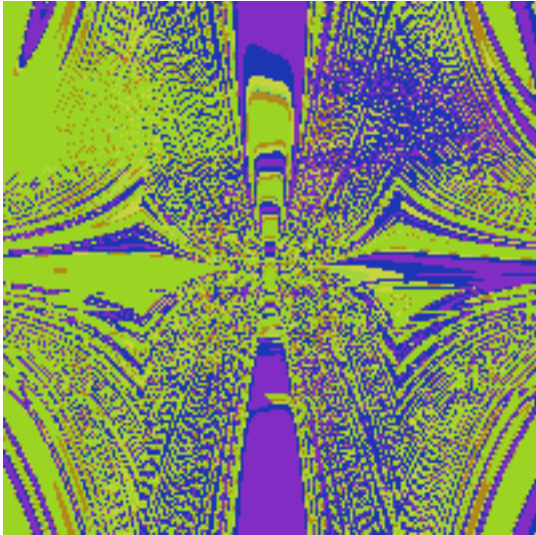
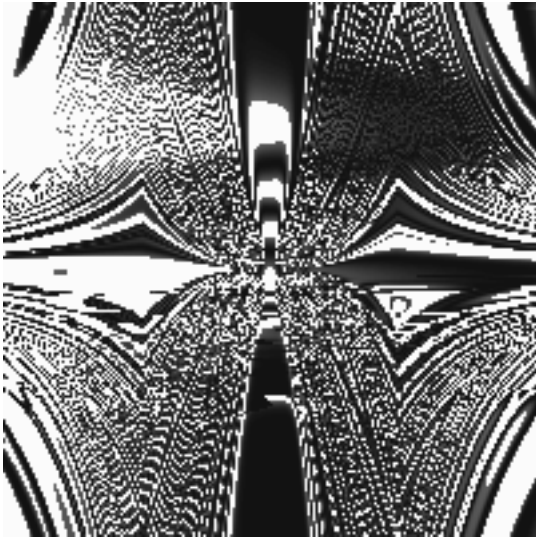
Original with three recolorings.



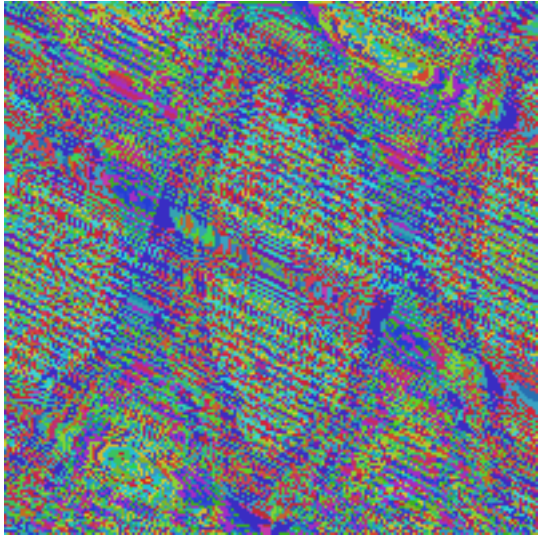
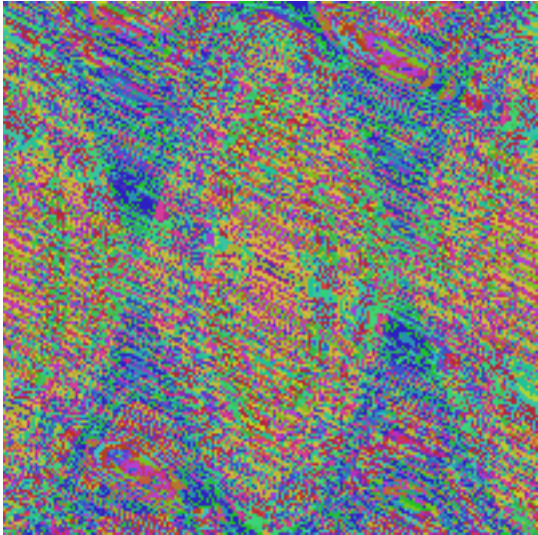
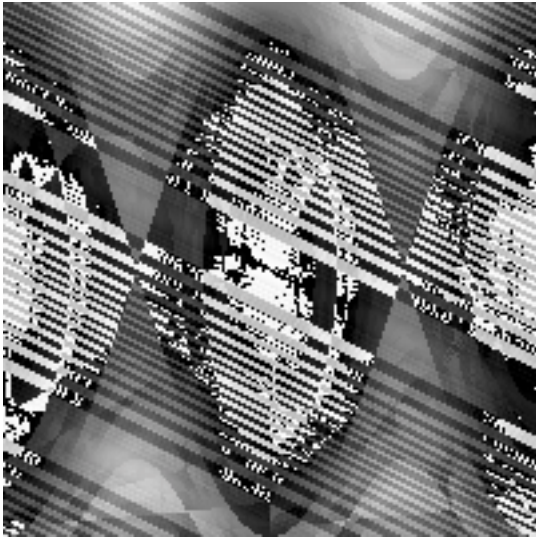
The corresponding thumbnails are of interest too.



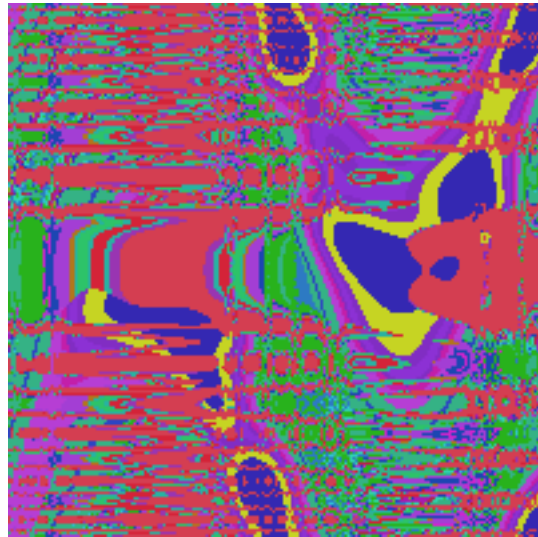
Gray-scale original and best recoloring.



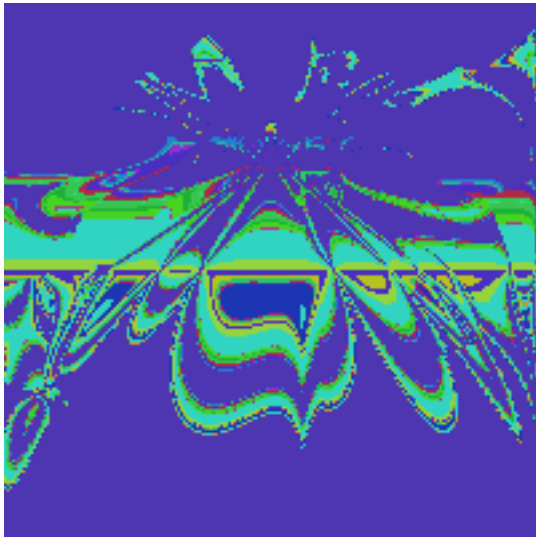
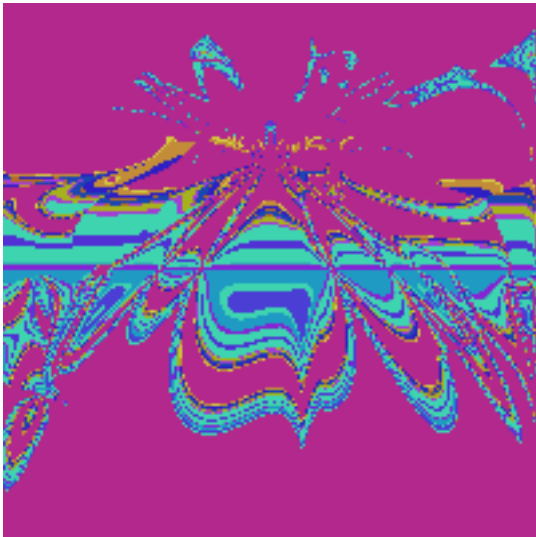
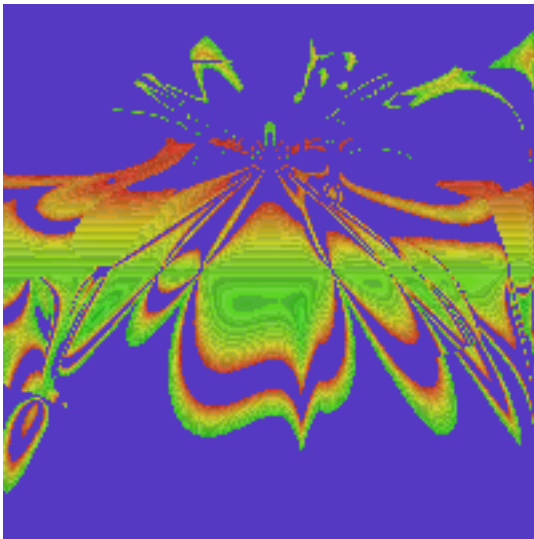
Gray-scale original with two recolorings.



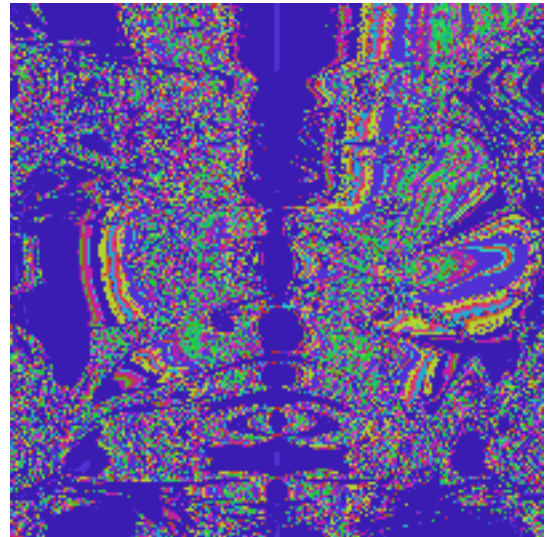
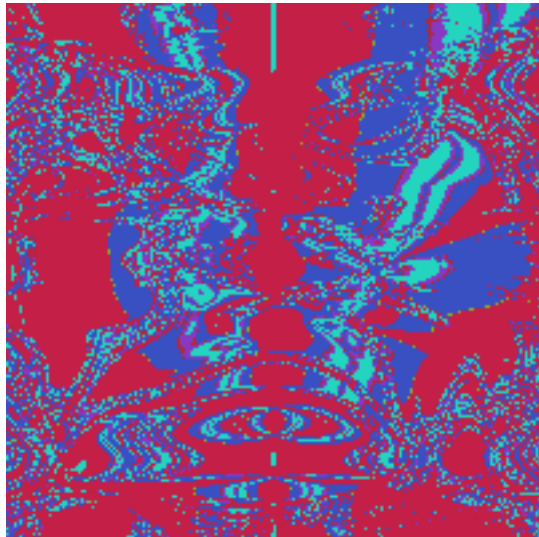
Unsuccessful gray-scale recoloring.

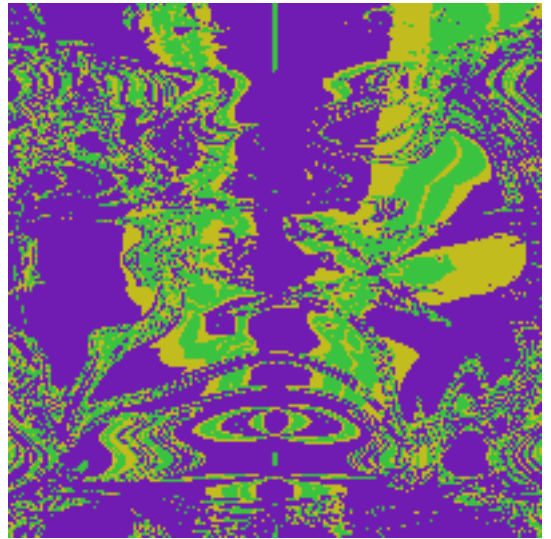
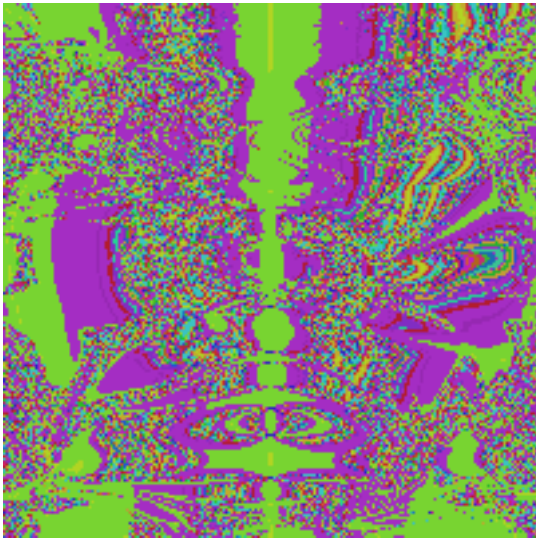
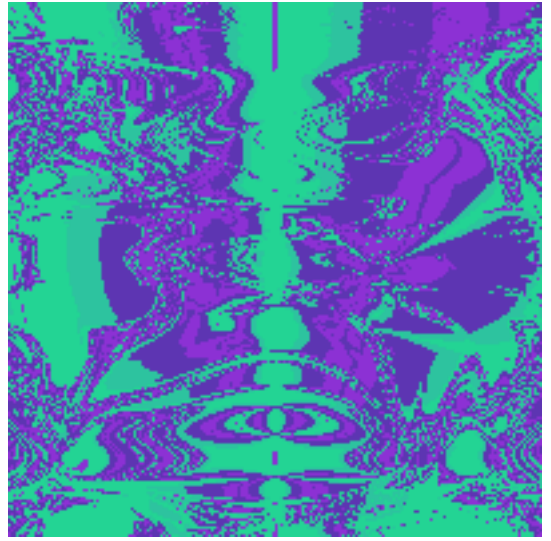
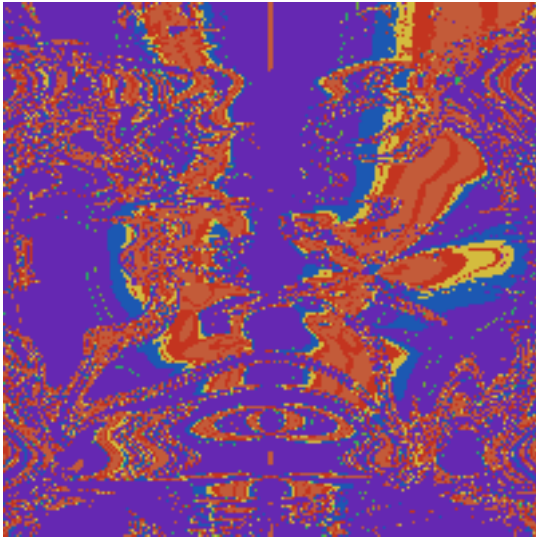


Color original with two unsuccessful recolorings.



Gray-scale original with seven unsuccessful recolorings.





VIII. Conclusions.

- A.** The fewer colors that are employed, the more successful the recoloring.
- B.** Designs with many large, juxtaposed, differently colored regions tend to confuse the automated color analysis algorithm.
- C.** Luminance criteria need to be taken into consideration.