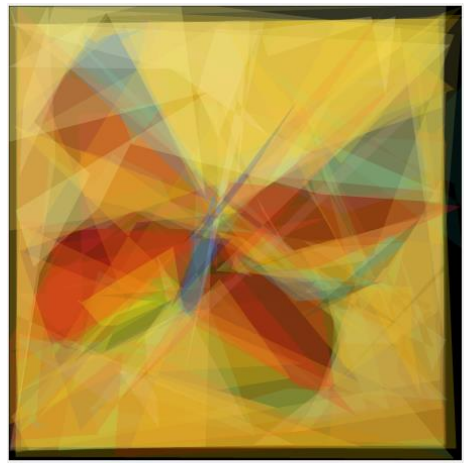
Ahmed Nouralla – AI Assignment 2 Report

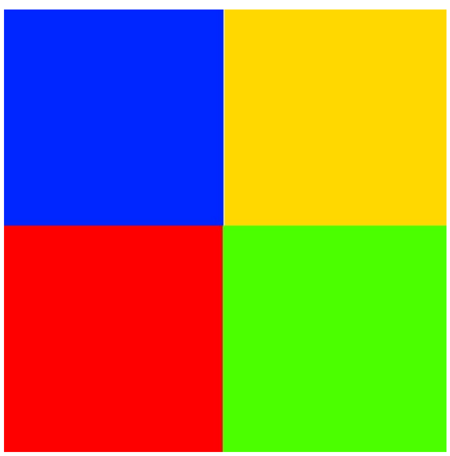
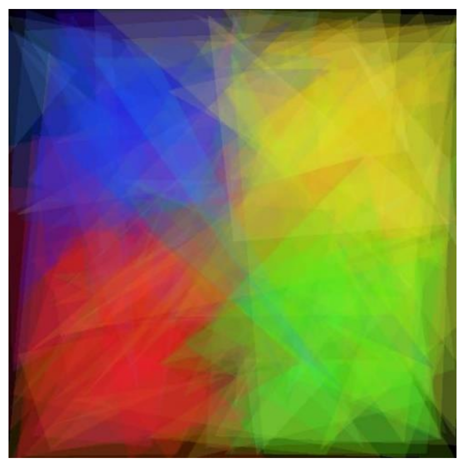
Algorithm description:

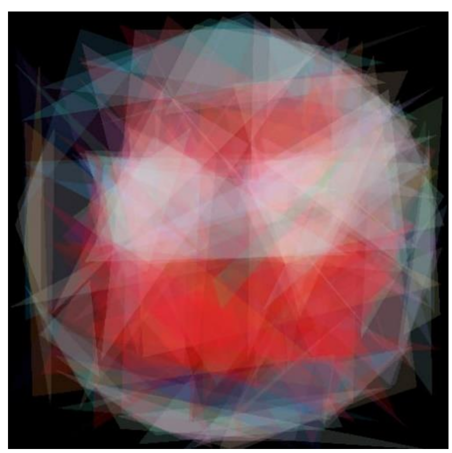
- The program takes a 512x512 pixel bitmap image and applies genetic programming (evolutionary algorithm) to generate another image (generated art), using a triangle brush (i.e., the generated image is composed of triangles of different colors, positions, sizes, each having some opacity value (alpha channel) and drawn on top of each other)
- **Genetic algorithm components:**
  - **Chromosome representation:**
    - A chromosome is a set of N triangles (each having a specific color and position), representing one of the possible solutions to the problem.
    - Each chromosome object contains an array $point[N][3][2]$ for positions on the screen, and another array $color[N]$ containing the RGB color values for each triangle in the chromosome, it also contains a field fit_val containing the fitness value for that chromosome, and a couple of functions for mutating, representing, and drawing the chromosome.
  - **Fitness function:**
    - The Pixel-wise Mean-Squared-Error (MSE) value between the input (reference) image RGB data and the chromosome to be evaluated (test image RGB data read from the screen) is used as a key for sorting population.
    - A comparator function based on fit_val is used to decide which chromosome should come earlier in order.
  - **Mutation technique**
    - Two variants for mutation are being used: $mutate\_disturb$, and $mutate\_change$
    - The first one (usually used) introduces small changes (uniformly chosen deltas) to the position/color of the chromosome being mutated, while making sure values do not go off-bounds.
    - The second one (less used) completely changes the position/color values, generating new random values that are uniformly bounded.
  - **Crossover technique**
    - Two variants for crossover are being used: one-point and n-points crossover.
    - The first one chooses a random point to be the crossover point, and swaps all triangles before it, leaving the rest unmodified.
    - The second one essentially does the same but decides whether to swap or not based on a randomly chosen value, thus modifying multiple subsets of triangles.
  - **Population size and selection technique**
    - **Population size** is a macro POP_SIZE defined at the beginning of the code that can be increased or decreased.
      - A low value will make the algorithm slower as it will require more generations to approach a good fitness.
      - On the other hand, a high value will hinder performance, as it will require more calculations per second.
      - A typical value of **30** that balances this trade-off is used for testing.
    - **Selection** is uniformly random, the algorithm only selects the best 25% of the population to remain, the other 75% are modified via mutation or crossover to generate a new population that evolve.

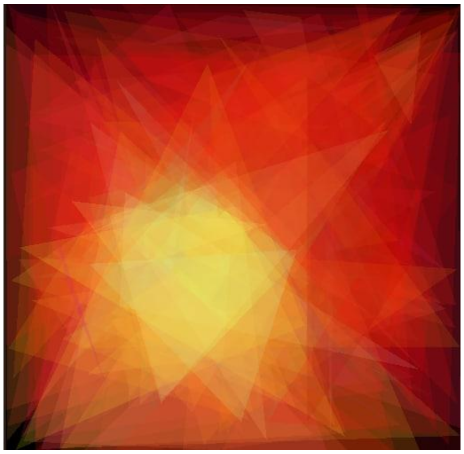
- The best 25% are chosen based on the fitness value, the population is sorted based on fit_val for each chromosome.
- To mutate or to crossover a chromosome is decided randomly, 95% of the cases are crossover-ed, and the remaining 5% are mutated.
    - Half of the population to be crossover-ed are using one-point crossover, the rest uses n-points crossover, n is also uniformly chosen.
    - 95% of the population to be mutated uses disturbing-mutation, the rest uses a complete-change mutation, see description above.

I/O examples (the output images were generated in 5 ~ 15 minutes, more time = better results)

Definition of Art

- There is no generally accepted definition of art, and personally I do not agree with the statement "Computers can generate art". The code described above essentially uses an input image, without which it cannot produce any result, the computer used a human-created art as a reference and defines the quality of its own art based on that reference through the means of fitness function and fitness value.
- Thus, the algorithm considers the input image as a masterpiece, the best generated art it can get to, is to generate a clone to that reference ($fit\_val = 0$) via the genetic algorithm.
- The output images from I/O examples above can be considered art in the sense that it represents the original image in a new way, abstracting it (first example), or adding an effect/flavor that gives a different impression to the observer (second example: generated image somehow looks better than the original as it is less sharp). This may appeal to the eye in the same way people like glitch-art or pixel-art for example, although they might look like - for others - a low-quality version of some original image.