Introduction to AI Assignment 2

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Representation

- Creature — image
- Past generation — creatures from previous generation
- New generation — creatures from previous generation and their mutated relatives
- Population — number of survived creatures
- Chromosome — coloured triangle primitive
- Mutation — blending creature canvas and canvas with one random rendered chromosome
- Genome — list of chromosomes
- Generation — iteration of evolutionary algorithm

Selection mechanism

Main idea of my selection mechanism is something like pie distribution.

New generation is sorted and then for each creature its part in next generation is calculated by this simple formula [1]

$$\Xi = \{\xi \mid F(\xi) < F_{max}\}$$

$$\begin{cases} P(\xi_x) = \left\lceil -\Pi \times \frac{1}{\sum_{\xi_i} \left\lceil \left(\frac{F(\xi_i) - min(F(\xi))}{F_{max}} - 2\right) \right\rceil} \times \left(\frac{F(\xi_x)}{F_{max}} + 1\right) \right\rceil \\ \sum_{\xi_i} P(\xi_i) < \Pi \end{cases}$$

where Ξ — creatures chosen for passing in next generation, Π — predefined length of population, $F : \Xi \to \mathbb{R}$ — fitness function, $P : \Xi \to \mathbb{N}$ — part calculation function, F_{max} — max fitness (fitness for zero matrix)

Manipulation mechanism

Manipulation is simple too.

1. Each creature from past generation is copied and mutated
2. Creatures from past generations and their mutated relatives are concatenated in one list and then sorted
3. For first several lucky creatures their part is calculated
4. Chosen creatures are copied for next generation according their calculated part

Fitness function

Fitness is calculated by Mean Squad Error function, which accept to arguments: source image matrix and creature image matrix

$$F(\xi) = mean(|M_{source} - M(\xi)|^2)$$

where ξ — creature, $M : \Xi \to \mathbb{N}^{512\times512\times4}$ — function returning creature image matrix ($512 \times 512 \times 4$ because I use alpha channel). F_{max} returns fitness for image matrix with all zeroes.

For source image fitness is 0.

Crossover function

> In last versions of my program there are no usages of crossover. I will explain why I refused to use it in the next section

1. Parents' chromosomes are concatenated and shuffled
2. Child gets half of shuffled parents' chromosomes
3. Child is rendered and its fitness function is calculated

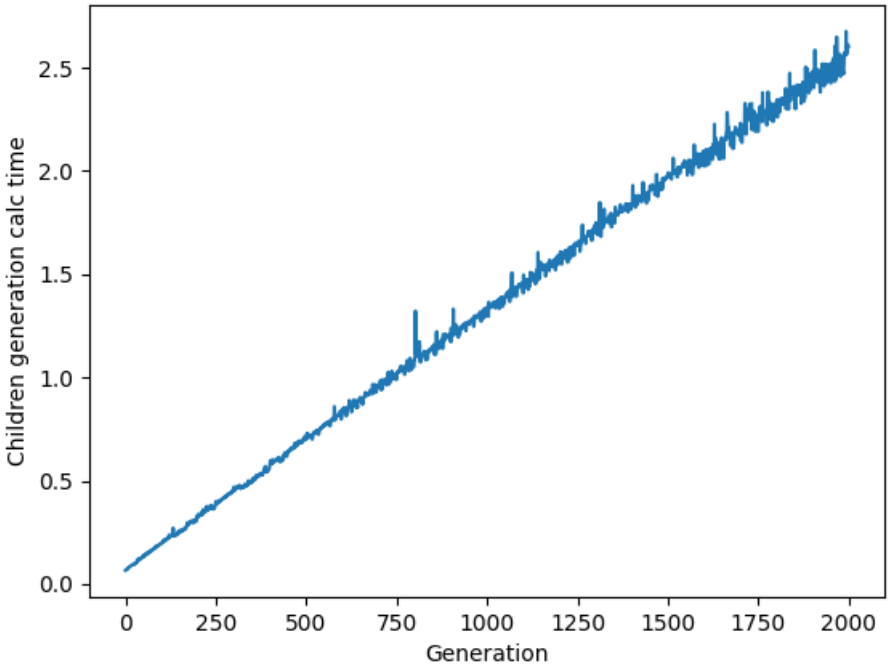
Performance and implementation issues

I worked really hard on this assignment and had achieved high performance due to this points:

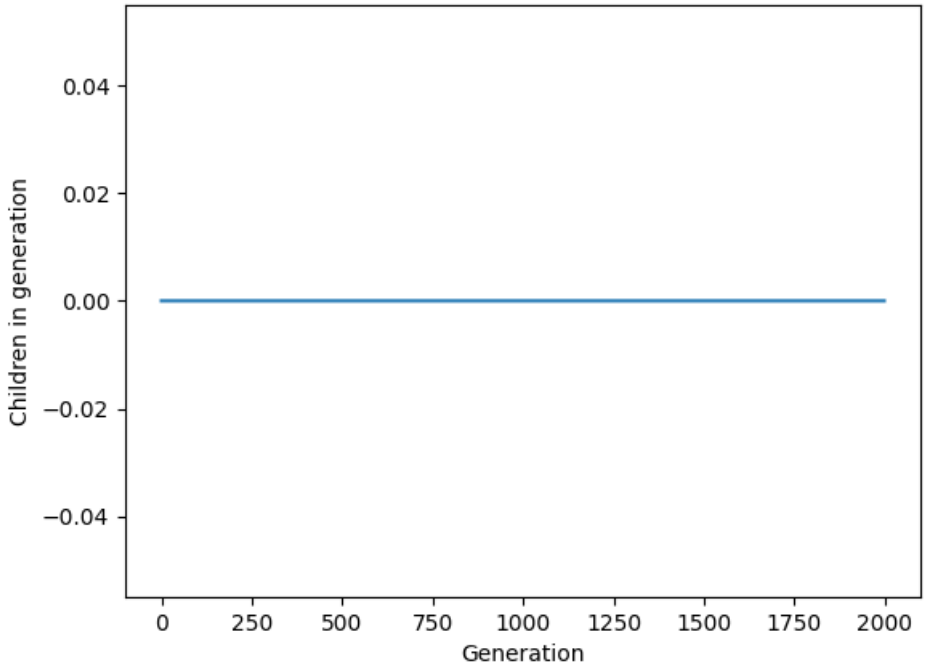
- Usage of NumPy arrays
- Usage of PyCairo rendering
- Fitness function JIT-compilation
- Random colour selection from source image color distribution
- Decreasing size of mutations

Using JIT-compilation and PyCairo library I had achieved very fast mutations ($\sim 200\ \mu s$ per one) and fitness function ($\sim 5\ ms$ per one calculation).

Anyway, there were some problems with crossover. Even though each primitive is drawn very fast, there is no boundaries for genome length and therefore crossover calc time is increased at a linear rate

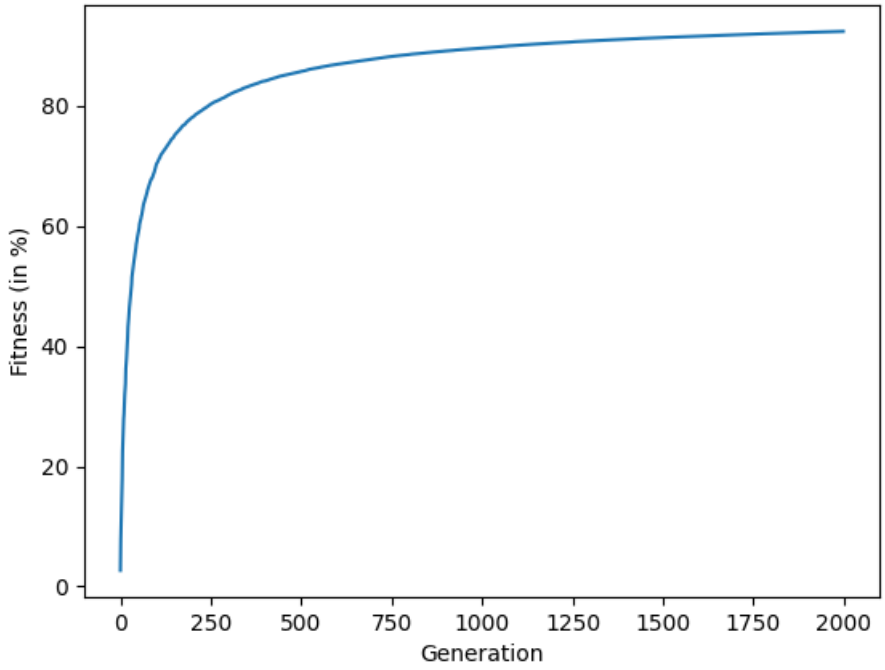


It becomes a problem after 100_{th} generation. The main problem is that crossover does not gain children fitted more than their parents



> This figure illustrates how many children get pass to the next generation

So this is the reason why I had rejected usage of crossover. Without it overall fitness grows very quickly



The reasons of such rapidly growing fitness are given in the next section

Mutation criteria

As mentioned above, in each generation half population consists of chosen creatures from past generation and another half consists of their mutated copies

Mutation itself consists of following steps:

1. Initialise new image
2. Colour is randomly chosen from colours of source image
3. Triangle primitive's coordinates are randomly selected in such a way that the size of triangle would be proportionate to best fitness
    - Since $F \to 0$, the more creatures are fitted, the less their mutation sizes
4. Triangle is drawn on initialised image
5. Image with drawn primitive is blended with creature image

My definition of art

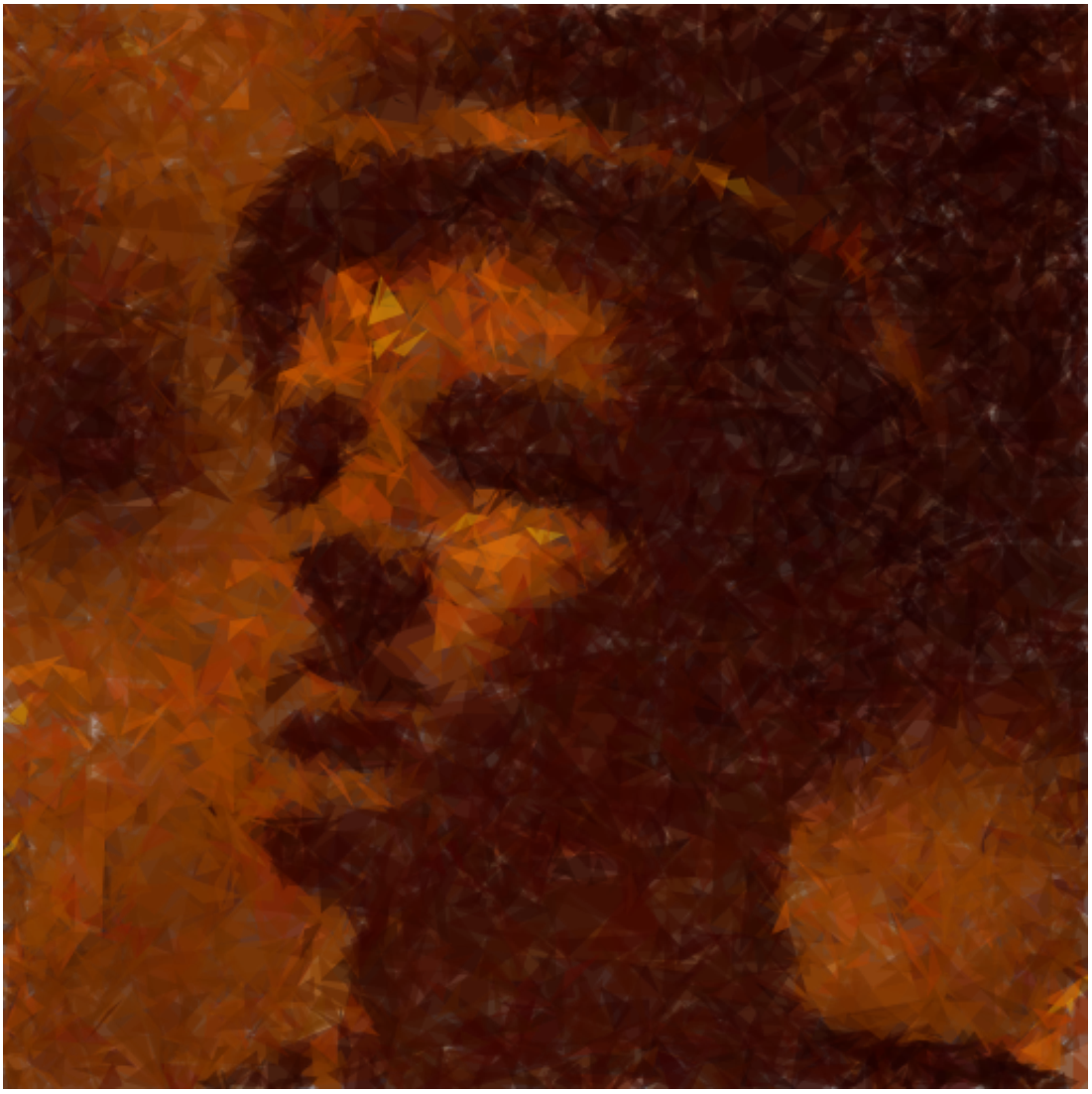
For me art could be everything if it holds some idea. This idea should raise thoughts about problem which concerns not only author, but other people too.

Artistic aspect of my images

First of all, I want to say that I was inspired by SUPER**HOT** and Steins;Gate games (to be precise, their art style)

In my pieces of art I want to show how our world (and not only our world) could be fragile and illusionary. You could think that images consist of pieces of broken glass

> My program generates not only images, but animated gif with half-way results. This gif should enforce effect of fragility.



1. This formula was derived by me with no plagiarism ↩