Individual Project

Project Proposal

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1 Introduction

In this document we will detail our initial project proposal. We will begin by outlining the scientific content of the project. Then we will go over the scope of the project and what we plan on delivering by the end of the process. Ending with a general plan of the process and proposed evaluation criteria.

2 Content

In short, we would to like to research and implement a program, which uses Genetic Algorithms to evolve new images based on feedback from a trained image classifier.

The resulting program could be trained to recognise certain images and in turn would hopefully be able to produce new images of the same kind. To achieve this we will divide the project in 3 phases.

2.1 Phase 1 - The Painter

In this first step we want to create an algorithm which given a reference image, can evolve a new image to look like the reference. In essence to "paint a replica" of the reference image.

We want to do this using Genetic Algorithms[1]. This involves encoding the image as set of genes, as an organism. It could be defining each pixel as a gene or each gene as a primitive 2D shape, etc.

Once such a genome is defined, pseudo-genetic processes are applied to these "organisms". This involves creating a population of organisms, grading each organism based on their "fitness" then applying natural selection to select organisms to procreate and populate the next generation. Through iteration, organisms with better and better fitness values will emerge.

In this phase, the "fitness" value is determined by how much an organism looks like the reference image. This can be done by simple pixel comparison.

Below are a few examples of this process:

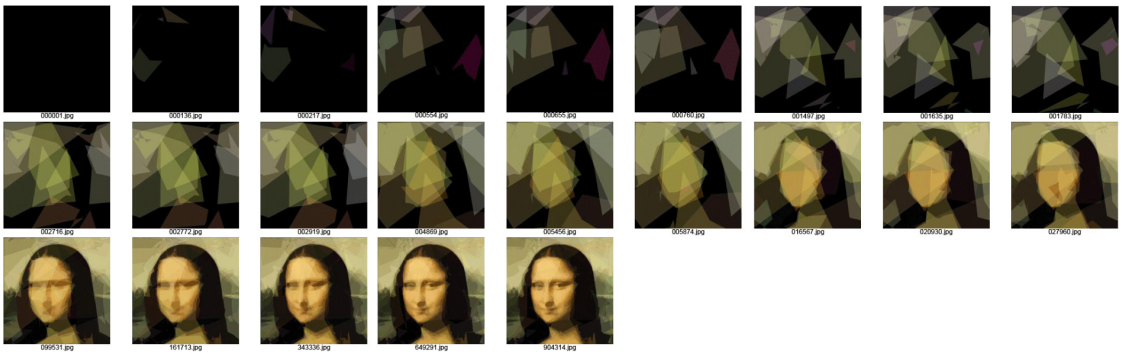

Figure 1: Genetic Programming: Evolution of Mona Lisa[2]

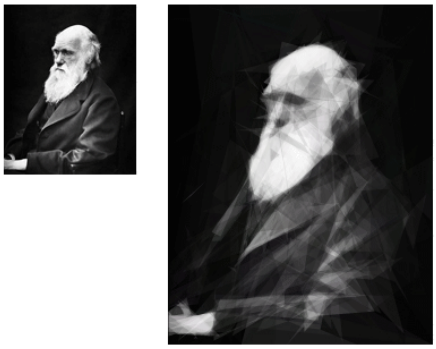

Figure 2: Genetic Programming: Evolution of Mona Lisa[2]

2.2 Phase 2 - The Critic

In the second phase we want to make use of an existing image classifiers through a ready-made model or an API. When the genetic algorithm is generating images, their "fitness" values will be determined by this classifier.

For example, a classifier that is trained to recognise birds in images could be used. It would look at each organism and their fitness score would be determined by how certain the classifier is that a bird is present in this image. Over time we are hoping that the genetic algorithm would produce images that look more and more like birds.

In such a way we are hoping that the "painter" will evolve images to satisfy the classifier's understanding of what a bird looks like.

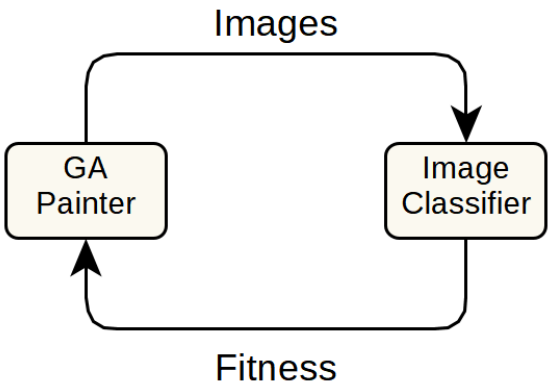

Figure 3: Art With Minimal Human Input?[3]

2.3 Phase 3 - Custom Classifier

If the previous phase was successful, we would like to build our own classifier. This would allow us to train the classifier on more carefully chosen datasets.

One example could be to train the classifier to recognise drawings of a certain art style, such as pointillism, and then could evolve new art in the same style.

One could also define the fitness function by combining several recognisable elements together, to see if and how the painter would satisfy them. For example, awarding points to organisms in which the classifier can recognise both a bird and a horse.

3 Scope and Deliverables

By the end of the project we want to have a program which satisfies the aforementioned functions. Together with a report that details our tests and findings that we produce while researching and implementing said program. Both of which, by end of the semester, can be incorporated in a presentation.

We find it difficult to assess the scope of the project as of now due to our lack of expertise. But the scope of this project lends itself to expansion if we determine it to be insufficient.

We could expand the first phase by testing additional optimisation algorithms, such as Hill Climbing[4] and Simulated Annealing[5]. Not to mention that genetic algorithms do not always guarantee finding the global optimum for our fitness function and could require testing different sets of parameters first.

In this stage we can also try different "painting" techniques, such as defining an image as a collection of pixels, fixed/variable amount of triangles, fixed/variable combination of polygons, etc.

In the second phase different models and types of objects that are recognised, could be tested. And as mentioned before, different combination of recognised objects could also be used as fitness values.

And in the final phase, different types of classifiers could be built and given the same datasets, to better understand how their internal "understanding of bird" for example, might differ.

4 Planning

As mentioned previously, it's still difficult to determine the length of each phase and if we can complete all of them.

But we plan on iteratively updating our report during our progress. We would share these intermediary reports with the projectguide(s) upon reaching a determined milestone.

We want to complete the report before the exam period and preferably also the presentation.

5 Evaluation

This project would be evaluated based on the final portfolio, which includes the implementation, report and presentation, a possible reflection as well as the intermediate progress. Possible evaluation criteria could include scientific quality, quality of reporting and presentation as well as project organisation and management skills.

6 Projectguide(s)

Prof. Dr. José Oramas and his doctoral student Salma Haidar, agreed to guide us in the image classification aspect of this project. We contacted Prof. Oramas due to his vast expertise in computer vision and image classification.

For the Genetic Algorithm portion of the project, we do not currently have a guide. This could change in the future.

6.1 Contact

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7 References

[1] Wikipedia Contributors. "Genetic Algorithm." Wikipedia, Wikimedia Foundation, 13 Mar. 2019, http://en.wikipedia.org/wiki/Genetic_algorithm.

[2] Johansson, Roger. "Genetic Programming: Evolution of Mona Lisa." Roger Johansson Blog, 7 Dec. 2008, http://rogerjohansson.blog/2008/12/07/genetic-programming-evolution-of-mona-lisa/.

[3] Data, Playing With. "Art with Minimal Human Input? An Image Classifier Judges a Genetic Algorithm." Medium, 19 Aug. 2018, http://medium.com/@ootsby/art-with-minimal-human-input-an-image-class

[4] Wikipedia Contributors. "Hill Climbing." Wikipedia, 24 Dec. 2019, http://en.wikipedia.org/wiki/Hill_climbing.

[5] Wikipedia Contributors. "Simulated Annealing." Wikipedia, 4 Nov. 2019, http://en.wikipedia.org/wiki/Simulated_annealing.