Anamorphic Art

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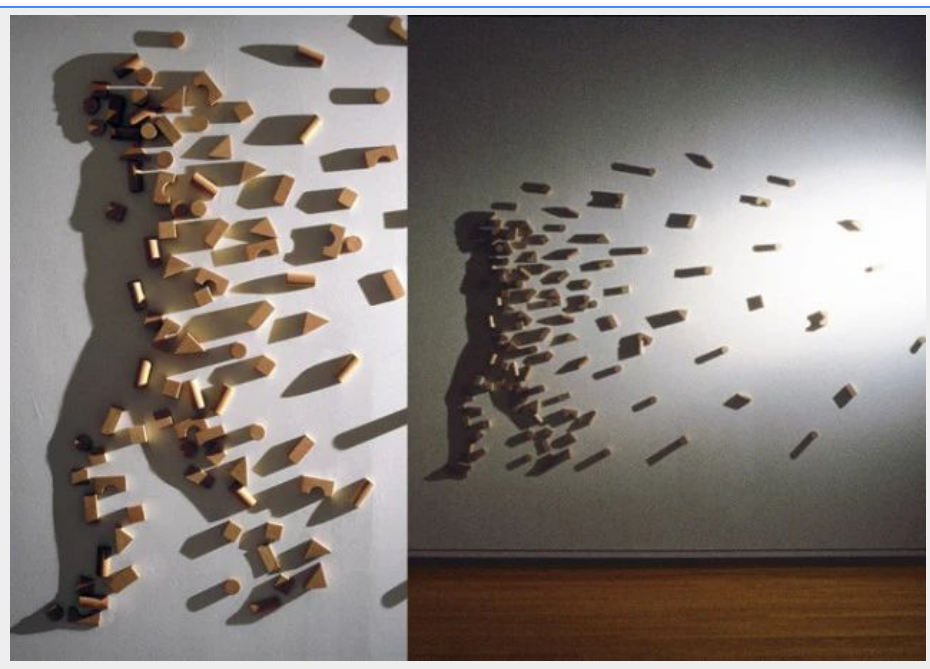
INTRODUCTION



It is possible to organise a collection of 3D objects so that when viewed from one angle, the projection appears to be an image of a certain object. In this project, our goal is to position and align a collection of 3D objects in order to create a 2D projection that closely resembles our target image. We were provided with a model that could generate such object arrangements but while generating such images, the objects were placed in such a way that there were some intersection between them which is not possible in real world. We sought to minimise the intersection while retaining the output projection image with the goal of having 0% intersection.

METHODOLOGY

We were provided with a model that could arrange the objects such that we are able to get the required output image on rendering that 3D arrangement. The given model did not constrained position of the objects. Since, there were not constraints except for the boundary, there were intersections among the objects. To remove these intersections, we decided to penalize the model on intersections. Earlier, the cost function was only dependent on image based loss, we added intersection loss to it.

To generate the positions where there are no intersections between two objects, we intend to move the pair of objects under intersections by the amount of half of the maximum of the distance between any two points that are under intersection.

To achieve what is written earlier, we draw an outline sphere and move the centroids of the sphere by the amount of common part between them. The new position of centroid is recognised by utilising the magnitude of intersection and the direction provided by the gradient of overlap distance for various points in the intersecting region.
We used centroid formulation instead of any ground truth for finding the optimal positions of the given 3D objects.

RESULTS

Figure 1, shows our target projection.
The figure shown below (Fig. 2) depicts the projection of objects arranged by the model with only MSE and L1 image losses in action. We then devised experiments to figure out how can we remove these 3D object intersections, without affecting the projection quality.

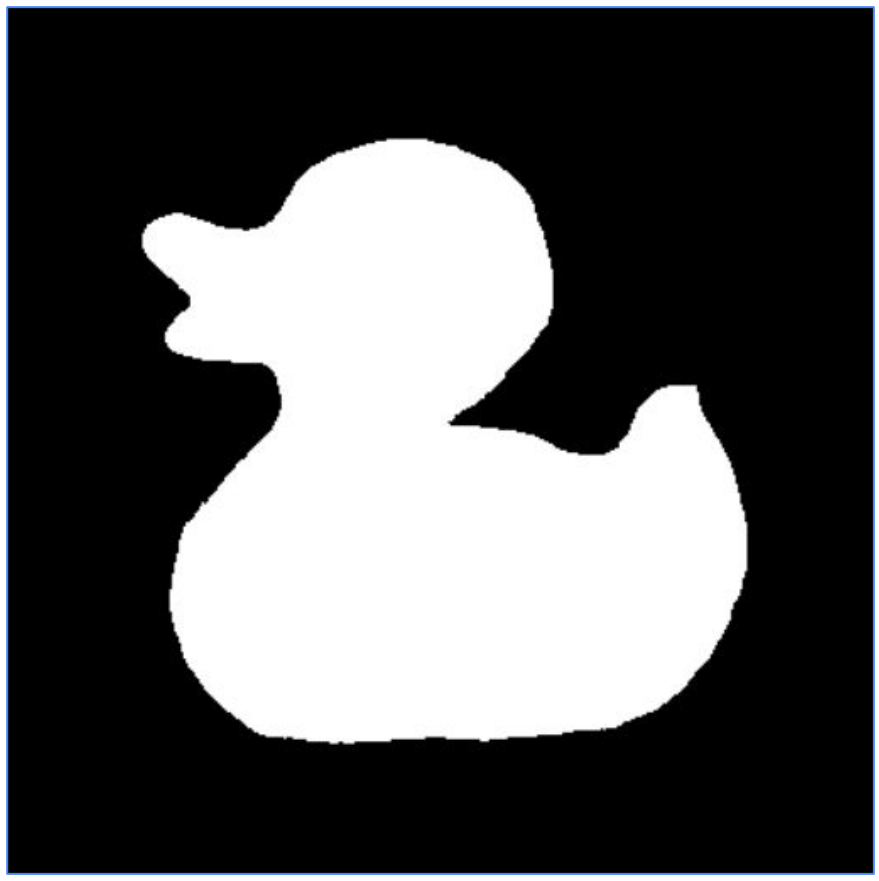


Fig. 1) Target Projection

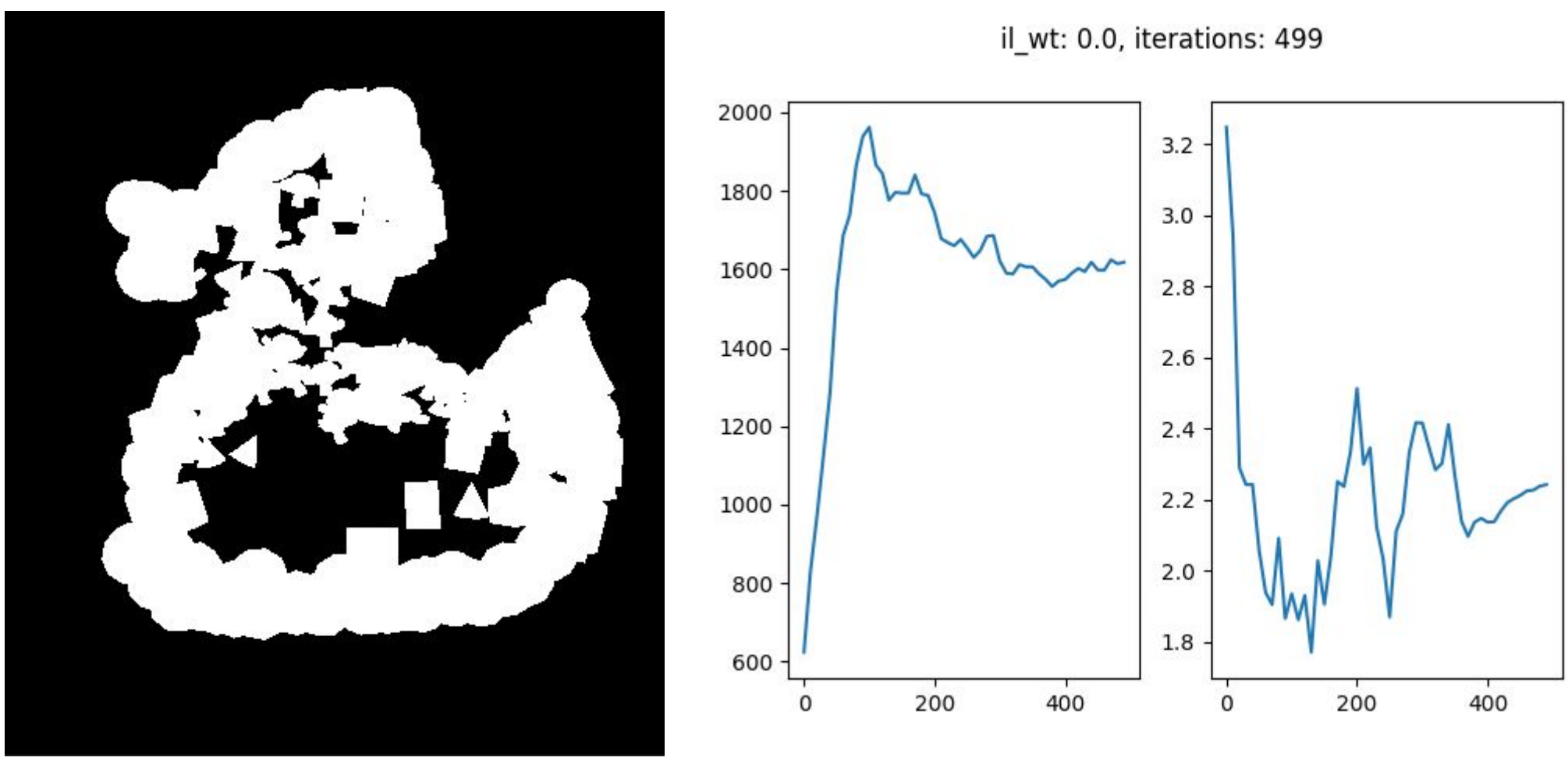


Fig. 2) Original Model's output projection (left) along with number of intersections and loss graphs.

RESULTS

We experimented with the following model and loss hyper-parameters:

1. Changing weights of different losses like intersection loss and mse loss
2. Adding SSIM loss for retaining structure.
3. We noticed that the intersection loss increased as the image started to form, so we also tried to first generate images only on the basis of image loss for certain number of iterations and then added intersection loss to it afterwards. This however, did not work as expected.

Below images show results of using different intersection loss weights. The first one, while having significantly lower number of intersections, puts out an unrecognizable image (Fig. 3.a). The second one has about 100 less intersections as compared to what we got without intersection loss, producing an image close to our target (Fig. 3.b).

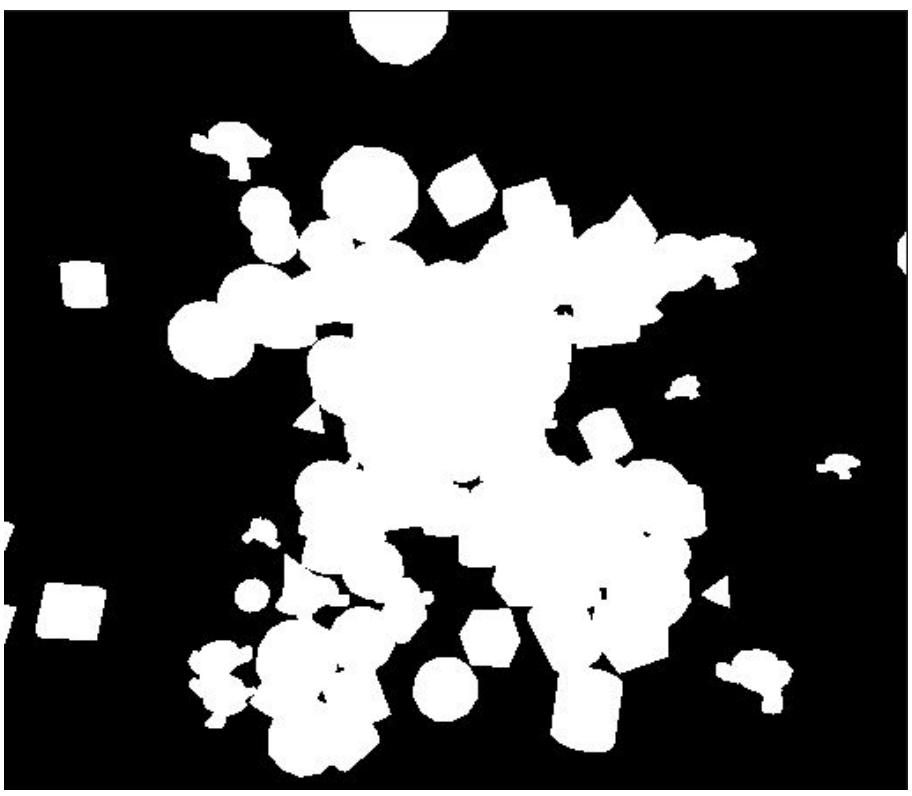


Fig. 3.a) 1e-04

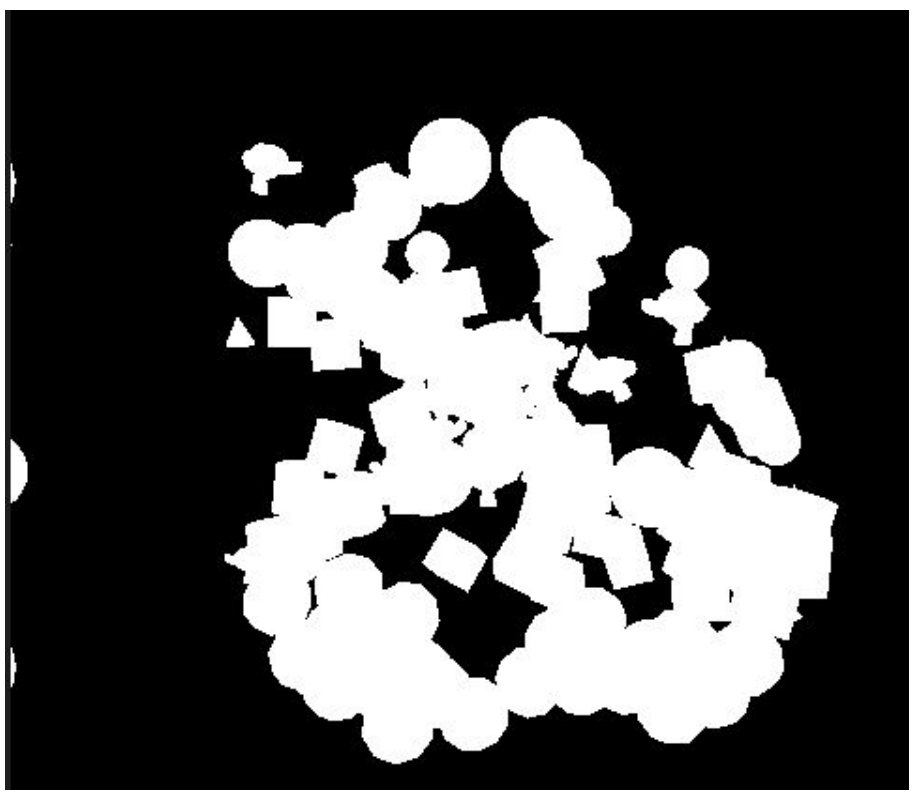


Fig. 3.b) 1e-06

Fig. 3. Output projections with different intersection loss weights

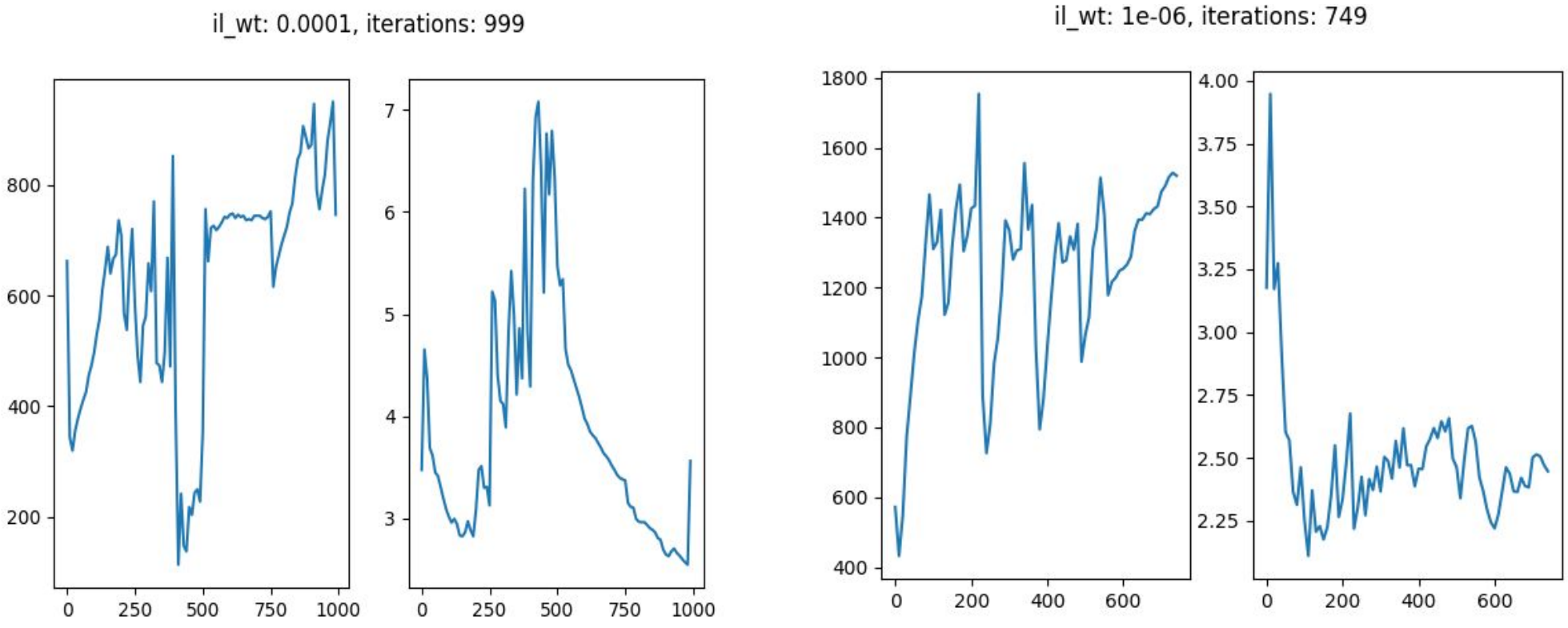


Fig. 4. Number of Intersections (left part) and loss (right part) graphs

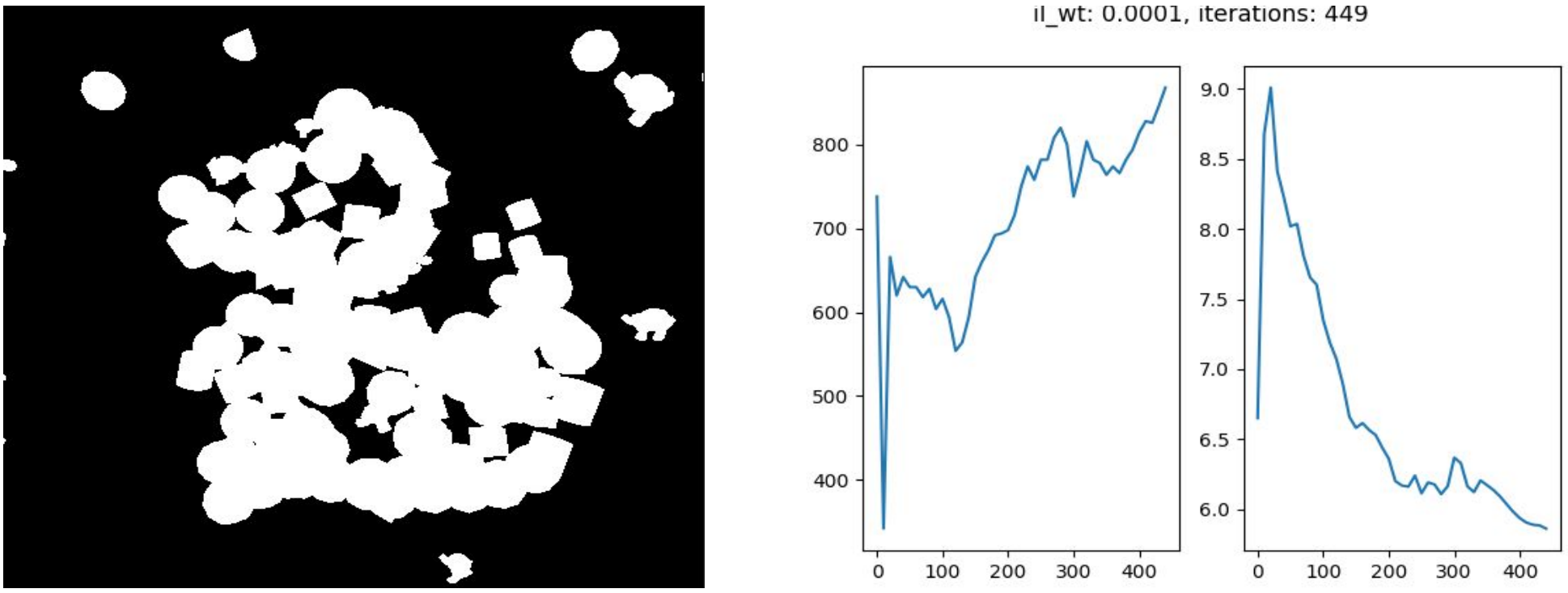


Fig. 5) Inclusion of SSIM losses

Adding SSIM loss significantly lowered the number of intersections while maintaining a desirable projection. We observe that the SSIM prevents the total cancelling out of the image losses by the intersection loss. And as it attempts to retain the structure, it also fills the empty spaces on the interior of the projection.

CONCLUSION

We were successful in minimising the intersections to certain extent, but we cannot reduce it to zero while following the current restrictions.
However, in a brief trial run of the model with lesser objects, with the same parameters we observed slightly better results.

LIMITATIONS and FUTURE WORK

Limitations:

1. We considered pixel based loss and intersection loss to be independent.
2. Unpredictable dominance of various loss factors.

Future Work:

1. To add sampling techniques for calculating the correct centroid positions only where intersections happen.
2. To change the model such that it automatically calculates the best number of objects required for generating the required images with zero intersections.
3. To include texture for the image

REFERENCES

[1] Miaojun Yao Zhili Chen Linjie Luo Rui Wang Huamin Wang. *Level-Set-Based Partitioning and Packing Optimization of a Printable Model*
[2] Tero Karras. *Maximizing Parallelism in the Construction of BVHs, Octrees, and k-d Trees*