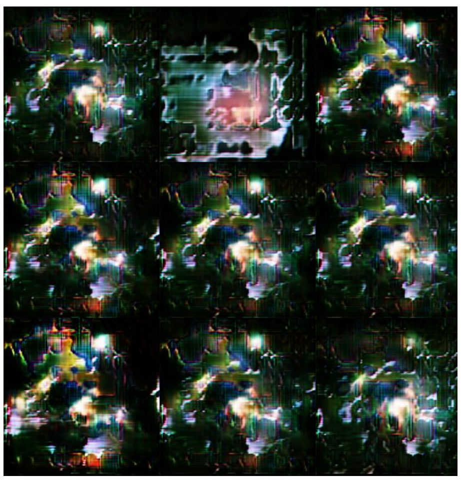
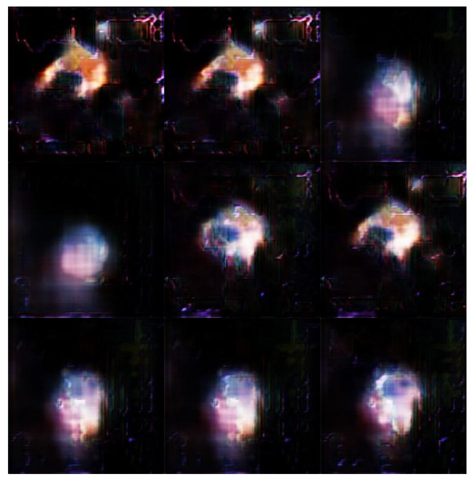
Machine Learning for the Arts
UCSD SPRING 2019
FINAL PROJECT

Primordial Soup

(a mixture of life components)





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DESCRIPTION

My goal was to show what biological and astronomical bodies have in common, and I believe my results are reflective of how all matter begins (and likely ends) in the same state: soup.

My role as the artist manifested in the development of my image dataset, which was made up of images that were scraped from Google and then approved by me! I ended up running this data through a 256x256 DCGAN which produced results that are included in my GitHub repository for this project and that were mounted for my presentation.

CONCEPT

I started out this project with the intention of pointing out the (aesthetic) similarities between microscopic structures (e.g. cells) and celestial structures (e.g. supernovae and nebulae) to show how the consistency of Creation can reflect the power and intelligence of the Creator. A perfect realization of this vision ended up eluding me, although my results did make me reflect on our (human) origins and the origins of the universe, especially with respect to the Divine.

I was originally inspired by conversations with my roommate, Sarah (a biologist and a devout Christian), *The Equations of Life: How Physics Shapes Evolution* by Charles S. Cockell (a book about how life, in its adherence to universal laws, is shaped less by chaos than we might think), Dana Scully from *The X-Files* (who so gracefully reconciled her faith with her skepticism every week for ten or so seasons of television), Bill Wurtz's *history of the world, i guess* (an iconic Youtube video that begins with the birth of the universe from quarks and other components of Matter Chowder™), and my own experience as a Catholic engineer. All in all I wanted to comment on how God can be found and understood by observing nature and studying its laws, in opposition to the attitude that those laws should be used as evidence against Her existence.

My results (as discussed below) lead to a soft reshaping of this concept and exhibit what I see as nature's base state--vibrant and beautiful blobs, or Primordial Soup, the medium from which both humans and nebulae have been made (by God, if you'd like, with time, gravity, etc.).

TECHNIQUE and PROCESS

Here's how to reproduce my results:

1. Have Python3 installed; PIL, Tensorflow, Keras, and google_images_download can be installed using pip.
2. Create and load your dataset:
    a. Import google_images_download; read the documentation here for information about arguments.
    b. Scrape images using appropriate keywords and save to appropriate folder.

   i. Note: Script can be run on a terminal, but for the sake of troubleshooting I ran it (locally) using a Python Notebook.
   ii. For this project, I used biology/astronomy related keywords (microscope cell staining, neuronal staining, nasa hubble images, etc.)

c. Once you have collected about ~500 images per category (I collected around ~500, but more can be used depending on availability, variety, and your patience), zip data folder and load into .ipynb file to run it through your GAN

3. Have Keras, PIL, and Numpy, and Matplotlib imported into your GAN file.
   a. The model is a DCGAN, which uses a generator NN which learns from the outputs of the discriminator NN that determines what is and is not a "good output".
4. Prep your data
   a. Running through your list of image paths, open each using Image, crop them into squares and resize to 256x256 RGB images.
   b. Convert these images to np.arrays of floats, which will be used as inputs for your GAN.
5. Run your model, test and tweak for results
   a. Adjust learning rate and batch size in the GAN class.
   b. Let the model train for as long as you can stand, and sift through your results folder for your favorite outputs.

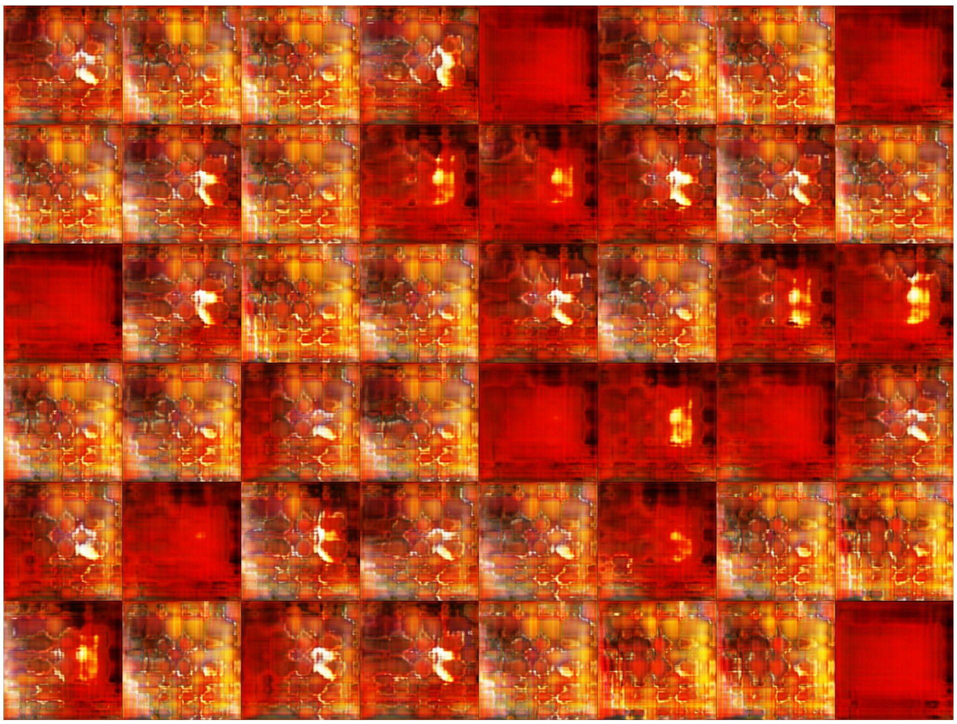
Data was augmented with "flipped" versions of the original images; I considered image rotation and adding noise for a larger dataset, but this mostly served to slow down the training process with minimal effect on the outputs.

Because these images were scraped from Google Images, which relies on a sensitive algorithm and is not at all reliable in terms of image consistency, it was necessary to sort through the data manually after it was collected to filter out unrelated images or images that might add unnecessary noise (like retail images, or online art, or slides from a university course). Related images didn't include enough variety or relevant results to continue scraping.

The first run through of training using the entire dataset exhausted the GPU, so I split up the dataset into subsets of about 100 images and ran it for a thousand or so steps for each. Adjusting batch size and waiting later in the training process allowed me to use the whole dataset eventually (as the parameters probably went through a less drastic change than in the first few steps (the first few steps, even with an image subset, were significantly slower).

RESULT

Results were output as 6x8 rectangles of 256x256 images every 1000 steps (an example was printed to the console every 500). Outputs varied DRASTICALLY, just as the data varied drastically, indicating that the discriminator was very sensitive to the images it had just seen, or at least their color and intensity. Patterns were more evidently learned and carried over (the example below, for example, likely show a cell-like pattern over an image of a supernova or other space explosion).



REFLECTION

I chose my exhibited results because they (or most) were produced late in the training process, but also because I preferred them aesthetically, or I was able to see something in the output, like an outline of the Eagle nebula, or a network of neurons.

I gained a lot of valuable experience data scraping for this project (and for this class in general), and I'd like in the future as a personal project to collect my own huge, clean dataset of these celestial/cellular objects and try this project again with more powerful hardware. I also want to do some more reading into what goes into a well structured visual GAN, how to resolve issues that apply to generative models as opposed to classification or predictive models, and how much of what a person can actually do goes into producing something great with ML and how much of it is just luck and a black box.

I am happy with the outputs that were created; I think that if I were to do this with objects that had a more defined structure (like lamps or shirts) I would have created outputs that looked nothing like I had wanted, but the characteristic chaotic shapelessness of GAN outputs were pretty compatible with the characteristic chaotic shapelessness of the subject matter.

Although I didn't see a perfect connection between embryonic cells and exploding stars, I think there's something to be said about how life on Earth (or anywhere) was (carefully and lovingly?) engineered from literal dust over billions of years, and how we as human beings find beauty and revelation in studying that life and that dust. Again, my results didn't lead me to any spiritual discoveries that burned my eyes out or caused the sky to open up, but I do think they brought me closer to a better understanding of God, or at least gave me some things to chew on.

REFERENCES:

https://github.com/hardikvasa/google-images-download : Google Image scraper

https://github.com/t0nberryking/DCGAN256.git : Base GAN to produce 256x256 images

CODE: **https://github.com/ucsd-ml-arts/ml-art-final-megan-visaya**

RESULT: Included in the repository linked above.