
LandGAN

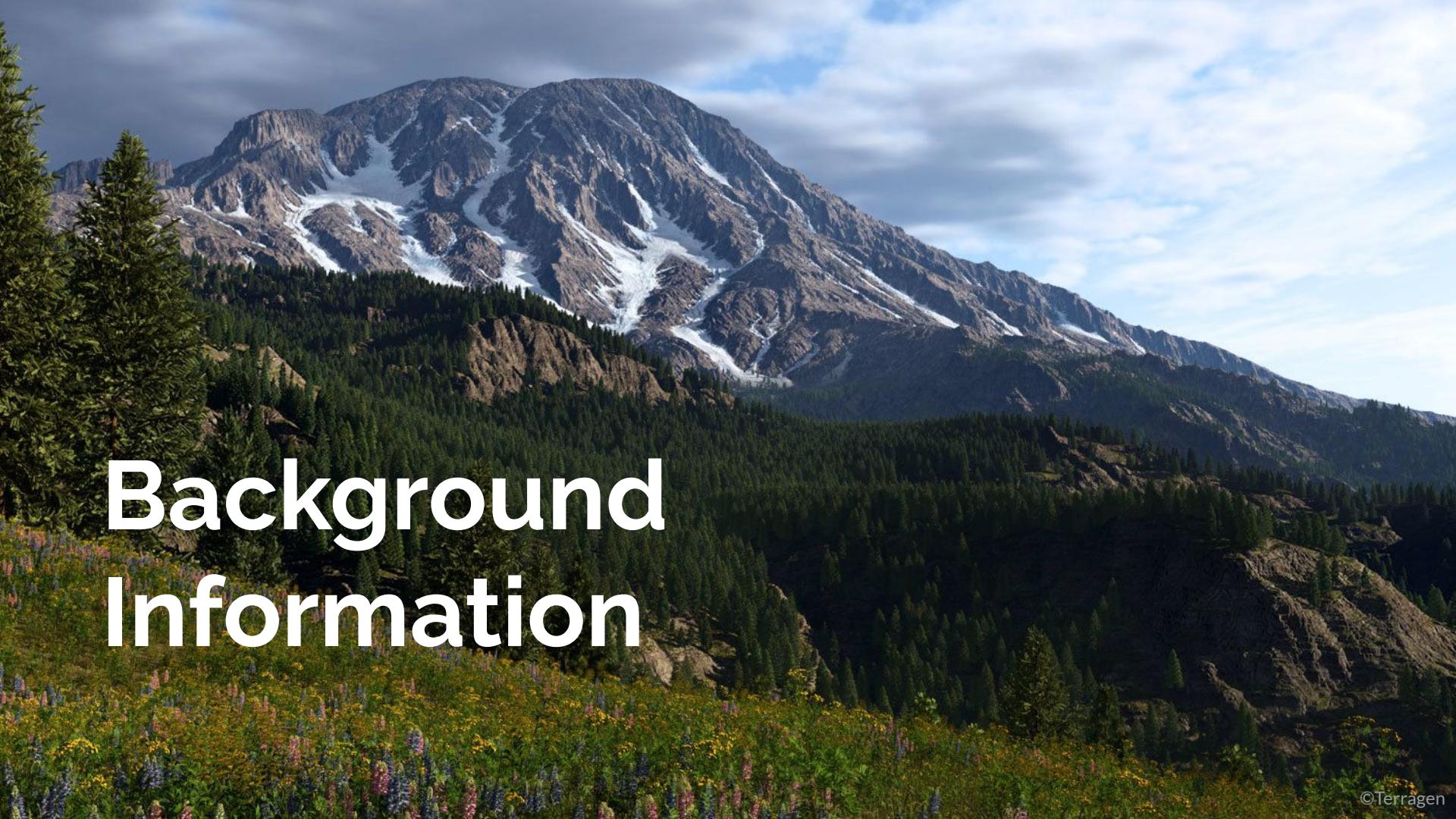
Exploring the use of Generative Adversarial Networks
for terrain generation.



Project Aims

- 1 Demonstrate the ability of a GAN to produce realistic and efficient terrain elevation and rendering.

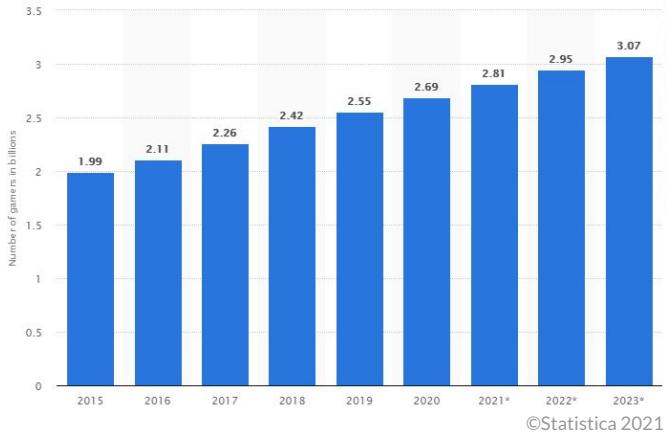
- 2 Form a discussion that compares the effectiveness of a GAN technique to more traditional algorithmic techniques.

A wide-angle photograph of a majestic mountain range. In the foreground, a lush green hillside is dotted with vibrant wildflowers in shades of yellow, blue, and pink. A dense forest of tall evergreen trees covers the middle slopes. The background features a massive, rugged mountain peak with steep, rocky faces and patches of white snow clinging to its upper reaches under a sky filled with soft, scattered clouds.

Background Information

Terrain in video games

Video Game usage is on the rise and there is increasing demand for more exciting, vast and accurate worlds. This project presents GANs as an alternative to traditional fractal and noise techniques.



©SSX EA

Existing methods



©Hello Games

Procedural Generation

Almost all aspects of "No Man's Sky" are procedurally generated. There are 18.4 quintillion individual planets. Life forms and terrain follow procedural rules and algorithms.

Fractal Techniques

Fractal techniques such as diamond square and midpoint displacement echo the fractal nature of natural landscapes.

©Terragen



©Assassin's Creed Unity

Combined techniques

Games such as "Assassin's Creed Unity" use procedural generation to automate aspects of development. The process is still largely manual.

Diamond Square

Developed in the 70s, this algorithm is still in use today in terrain generation tools such as Terragen.

Merits

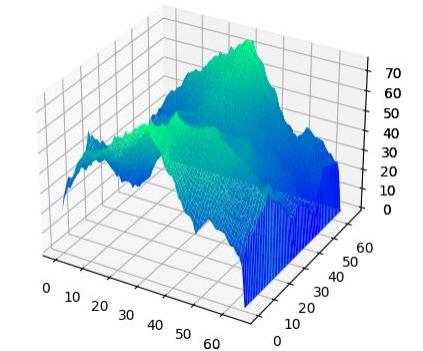
The diamond square algorithm is fast and uses very little memory. The algorithm is more complex than midpoint-displacement but there are less artefacts and it takes the same amount of time/ memory.

Drawbacks

Some artefacts still remain, e.g “pinches” between areas. The resulting landscapes can also be either too repetitive or too random. This method does not include anything other than the heightmap, textures etc can be added manually or using rules.



©Terragen

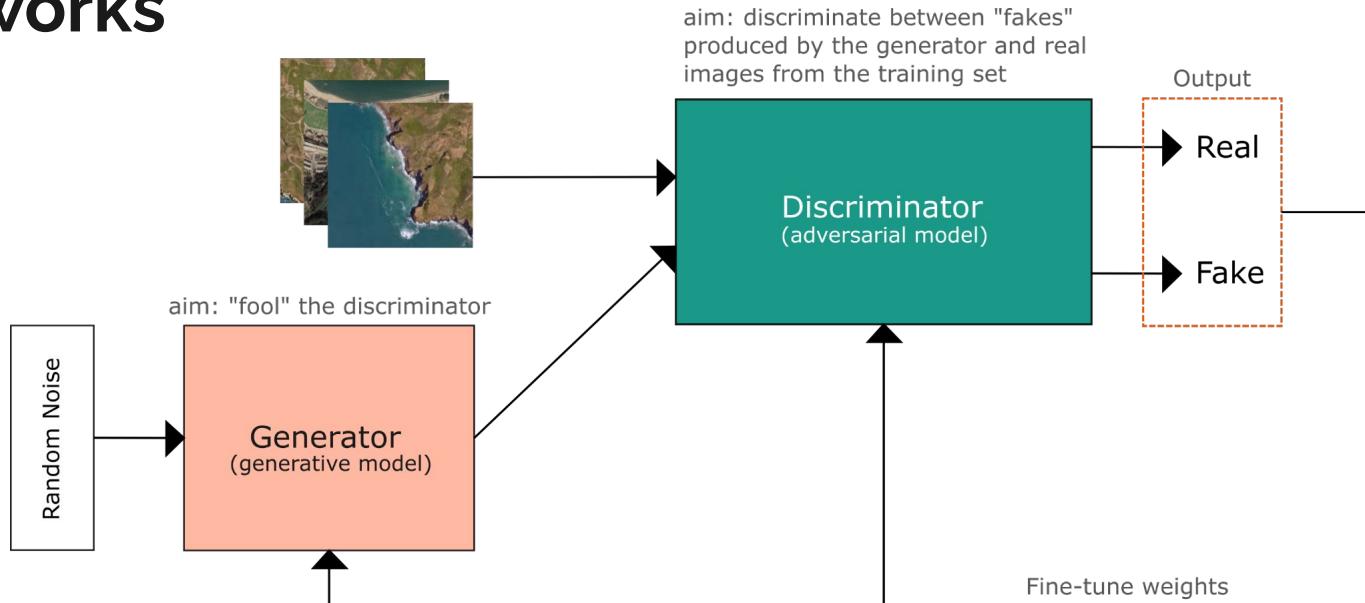




Note

Show diamond square code and
matplotlib results here! Delete slide
before presenting

Generative Adversarial Networks





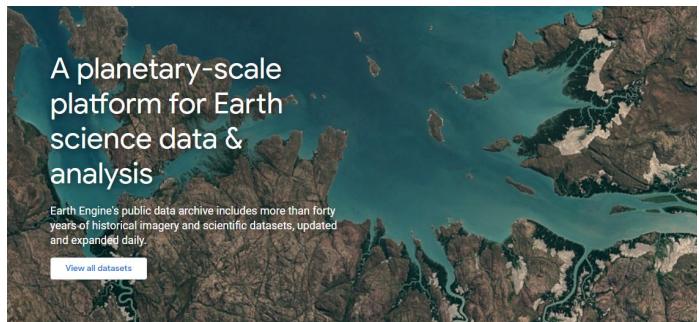
The dataset

Sourcing the Data

There are a wide variety of free satellite datasets available online. Google earth uses a combination of these datasets to find the most accurate image of any area. This accuracy and the (seemingly) simple API were the reason I chose the google maps platform for my dataset creation.

Combined Satellite/ Elevation Data

I could not find a dataset containing the data in this format so I decided to create the dataset myself. The resulting data is another unexpected, but incredibly useful, outcome of this project.



```
center = str(lat) + "," + str(lng)
url = "https://maps.googleapis.com/maps/api/staticmap?center=" + center + "&
filename = "dataset_creation/outputSatImg/" + areaID + str(col) + "," + str(r

satImage = requests.get(url)
img = tf.image.decode_png(satImage.content, channels=3)
img = tf.image.crop_to_bounding_box(img, logoHeight, 0, picWidth, picHeight)
```

Problems Faced

Due to the lack of an accessible dataset, creating a suitable dataset was the most complex and time consuming part of the project.

- | Converting lat/long coordinates to world coordinates
- | Adding a 4th channel (elevation) to an image
- | finding the relevant lat/ long for each pixel
- | API request limits
- | Interpolating the elevations to cover the image
- | Limitations of the Maps API service

How to get bounds of a google static map?

Asked 8 years, 7 months ago Active 2 months ago Viewed 16k times

answered Feb 6 at 14:21



hulleylm
11 • 4

hulleylm fixed typos		069afaz on 24 Feb	15 commits
	Pipfile	added script modified from landgan	3 months ago
	Pipfile.lock	added script modified from landgan	3 months ago
	README.md	fixed typos	2 months ago
	maps_tiler.py	renamed	2 months ago
	sanFranFiles.png	compressed examples for README	3 months ago
	sanFranTiled.png	Add files via upload	3 months ago
README.md			

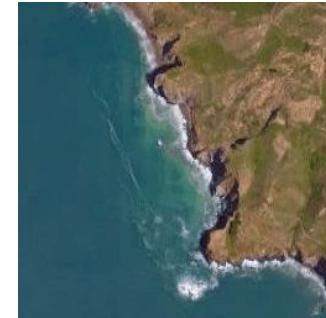
Tiling the Google Static Maps API.

This Python script produces satellite images than can be tiled together to cover a larger area. Any improvements very welcome!

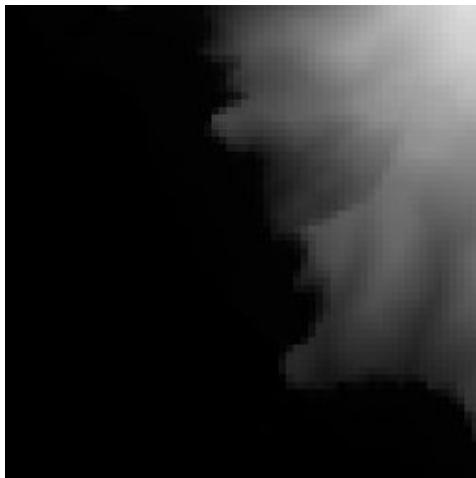
Inputs

You can see all the inputs this API takes and explanation of those listed below, [here](#).

Selecting the Interpolation Method



Nearest



Linear

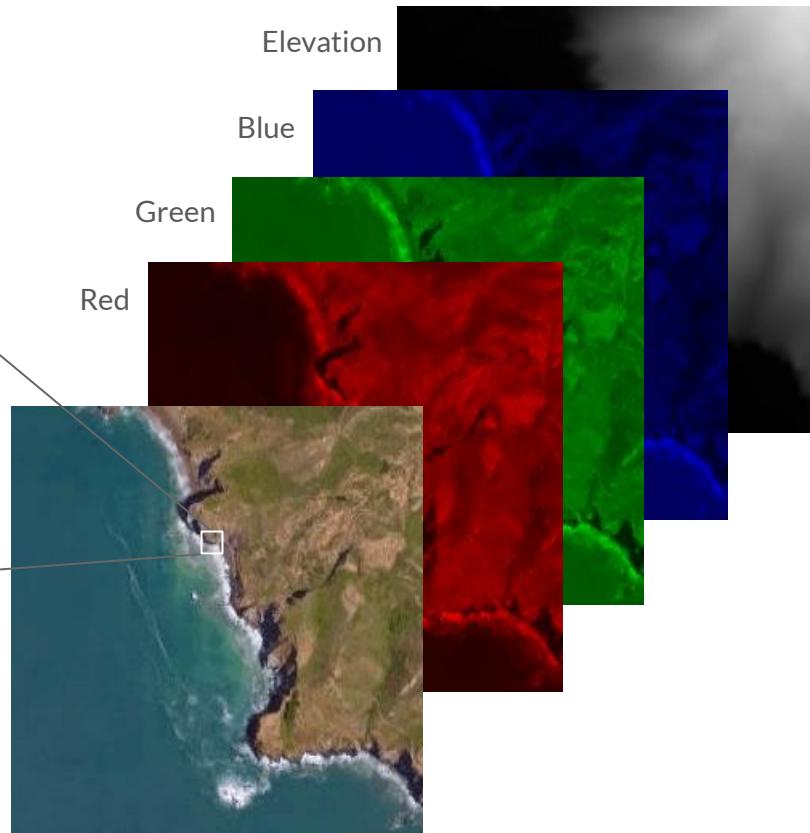


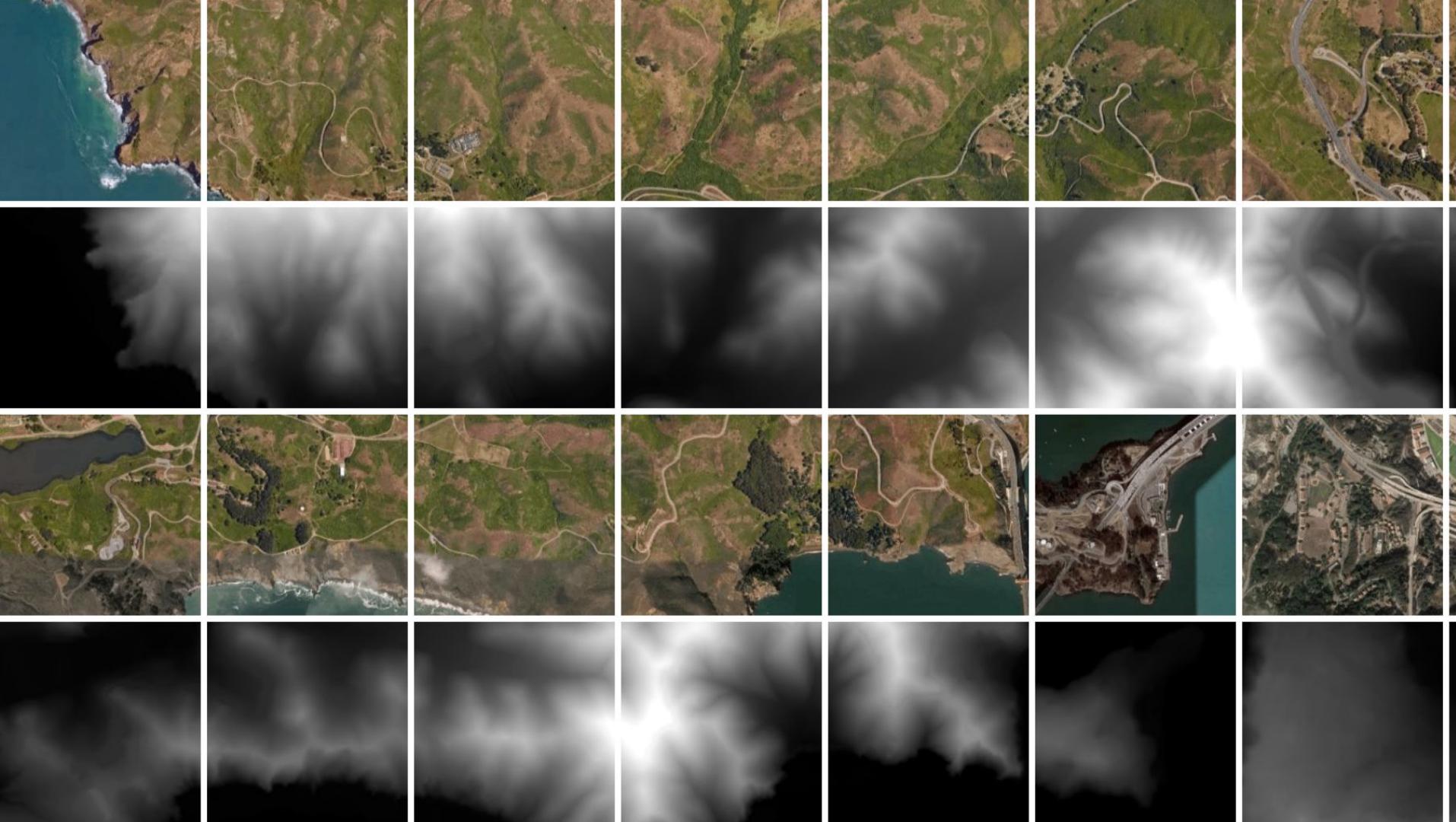
Cubic



Data Format

Latitude & Longitude: 37.837041,-122.550406
Red: 171
Green: 175
Blue: 191
Elevation: 0.3426







Note

Show dataset code and unity models
here! Delete slide before presenting

The background image is a high-resolution aerial photograph of a desert environment. It features a complex network of dry riverbeds and oases. Several large, bright green areas represent permanent water sources, while the surrounding land is a mix of tan, brown, and dark grey, indicating different types of desert soil and rock. The overall pattern is organic and somewhat abstract.

Training the GAN



Note

Show GAN code, results and unity models here. Talk about development environment, git, unity, vscode, pipenv, pickle, tensorflow

Ethical Considerations and Data Protection

Third Party Data Sources

The google terms of service state that their logo/ attribution must not be modified. Originally i trimmed the logo from the images before realising this breaches their ToS.

Ownership of Data

Ownership and copyright of data produced by GANs is a heavily debated topic. This is covered in further detail in my dissertation.

Job Replacement

Due to the aim of this project, the prospect of job automation in the game design sector must be considered.



$$\min_{\mathcal{G}} \max_{\mathcal{D}} \mathbb{E}_{\pi} [\mathcal{L}_{\mathcal{G}}(\mathcal{D})] + \mathbb{E}_{\mathcal{G}} [\mathcal{L}_{\mathcal{D}}(1 \cdot \mathcal{D}[\mathcal{G}])]$$

To be Discussed in the Dissertation

1

Testing and Evaluation

A large part of this project is the comparison and evaluation of different methods. Quantitative and Qualitative tests are completed and described in more detail in my dissertation.

2

Evaluation Against Original Aims

The tests described in the point above are necessary to evaluate Aim 2: the comparison.

3

Self Reflection

A reflection on what went well and what could have gone differently in the project.

4

Evidence of Research into Existing Games

Although existing games are discussed in this presentation, the evidence behind these points is in the dissertation.

Scope for progression

HPC

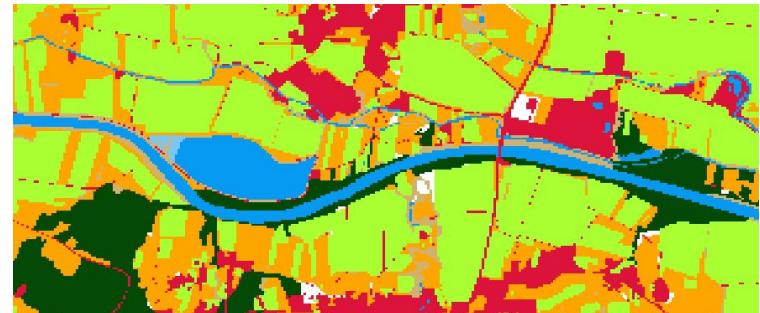
Currently, my model is trained using the free Google Cloud GPU. If I had more time I would have used Barkla, the university's HPC service.

Extra Data (e.g land cover, climate)

More channels could be added to the data which cover the climate and land cover type in the area. This would aid the conversion of the data into playable world environments.

Combined Techniques

If a 5th channel of land usage data were to be added, software similar to GauGAN could be created. This would allow designers to draw maps which then have textures and elevations generated by the GAN.





Aerial photograph of agricultural land featuring several rectangular fields. The fields are filled with different colors of water or crops, including dark green, light green, and brown. A network of white irrigation canals connects the fields. The surrounding terrain is a mix of light brown and green, suggesting a transition between cultivated land and natural vegetation.

Thank you for listening