LandGAN

Exploring the use of Generative Adversarial Networks for terrain generation.

Project Aims

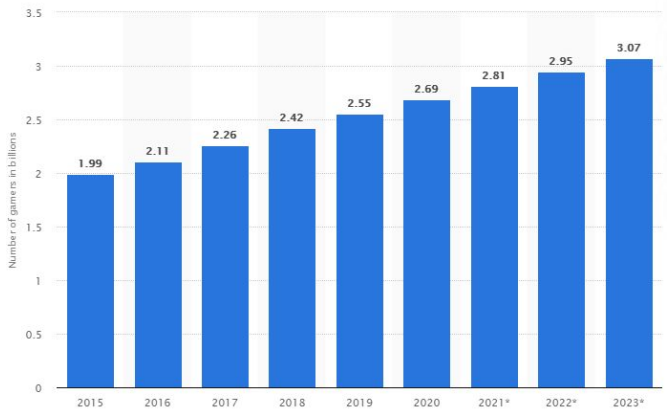
1. Demonstrate the ability of a GAN to produce **realistic** and **efficient** terrain elevation and rendering.

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


Background
Information
©Terragen

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.



©Statistica 2021

©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

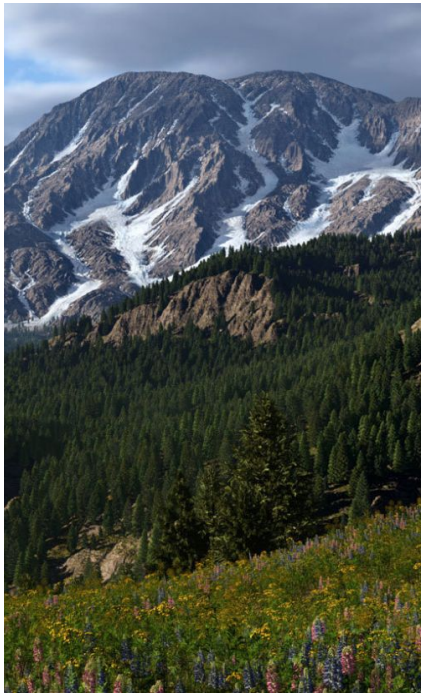
Developed in the 70s, this algorithm is still in use today in terrain generation tools such as Terragen.

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.



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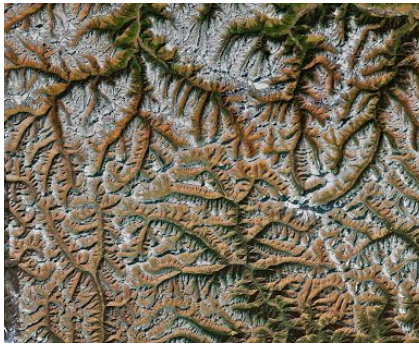
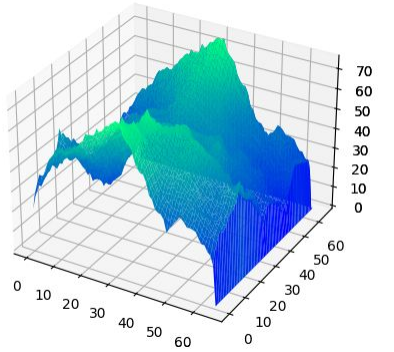
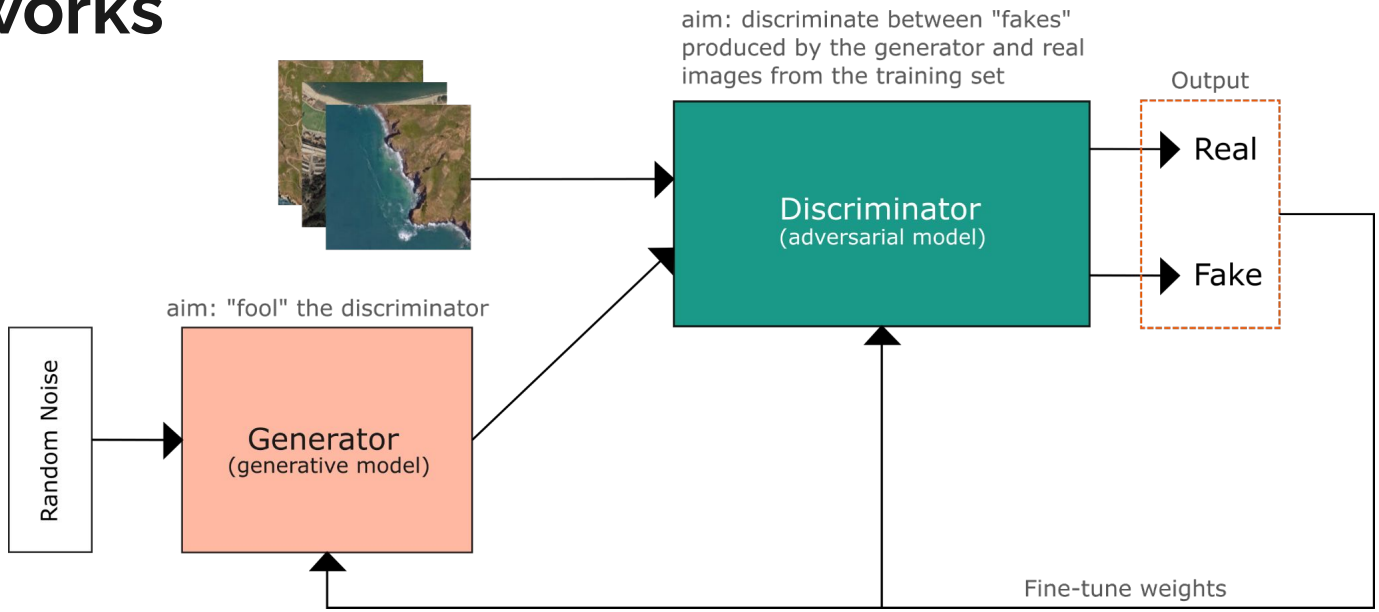




Note

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

Generative Adversarial Networks




The dataset
© TerraMetrics
Google Earth

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.

Google Maps Platform

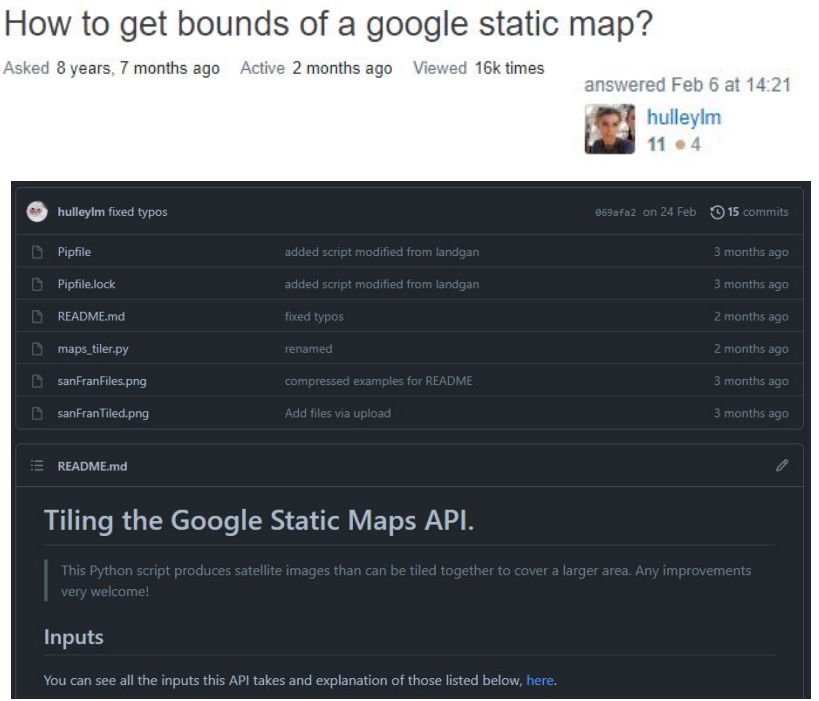

```
center = str(lat) + "," + str(lng)
url = "https://maps.googleapis.com/maps/api/staticmap?center=" + center + "&
filename = "dataset_creation/outputSatImg/" + areaID + str(col) + "," + str(r

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



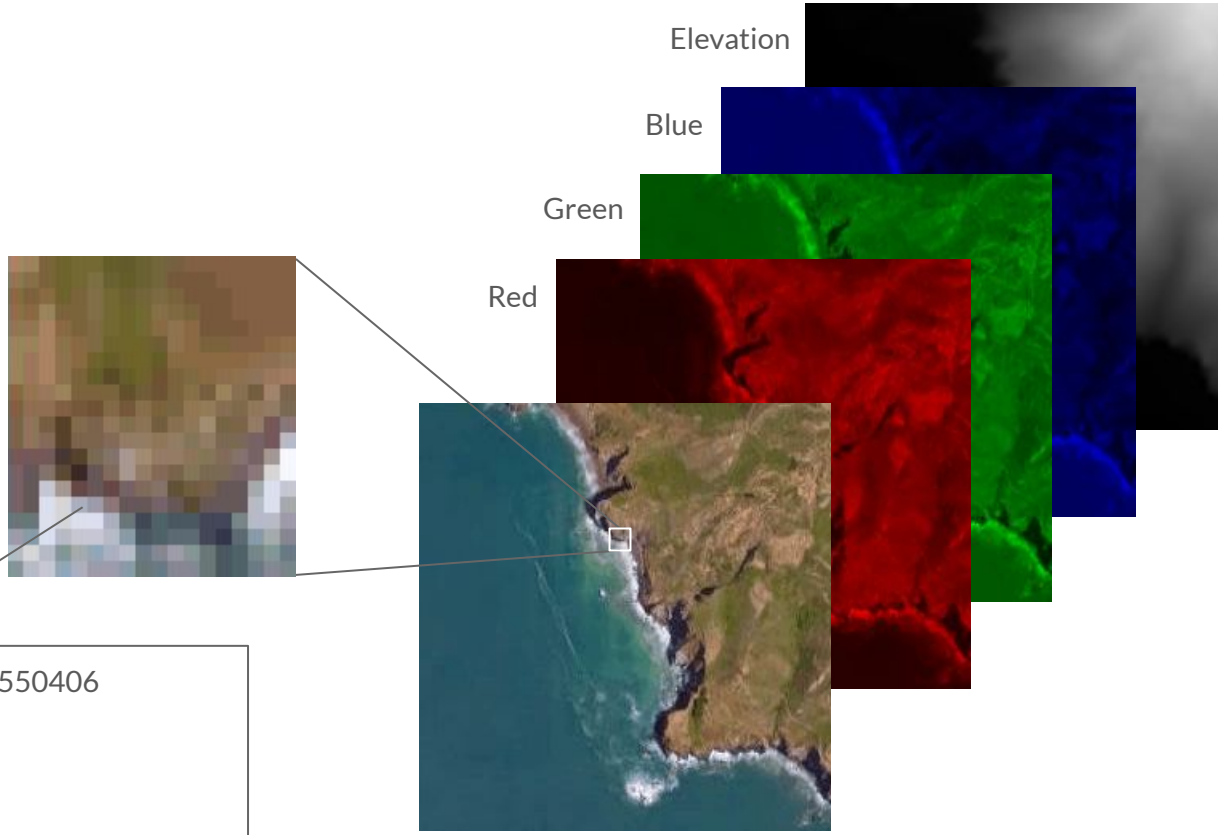
Selecting the Interpolation Method

Nearest

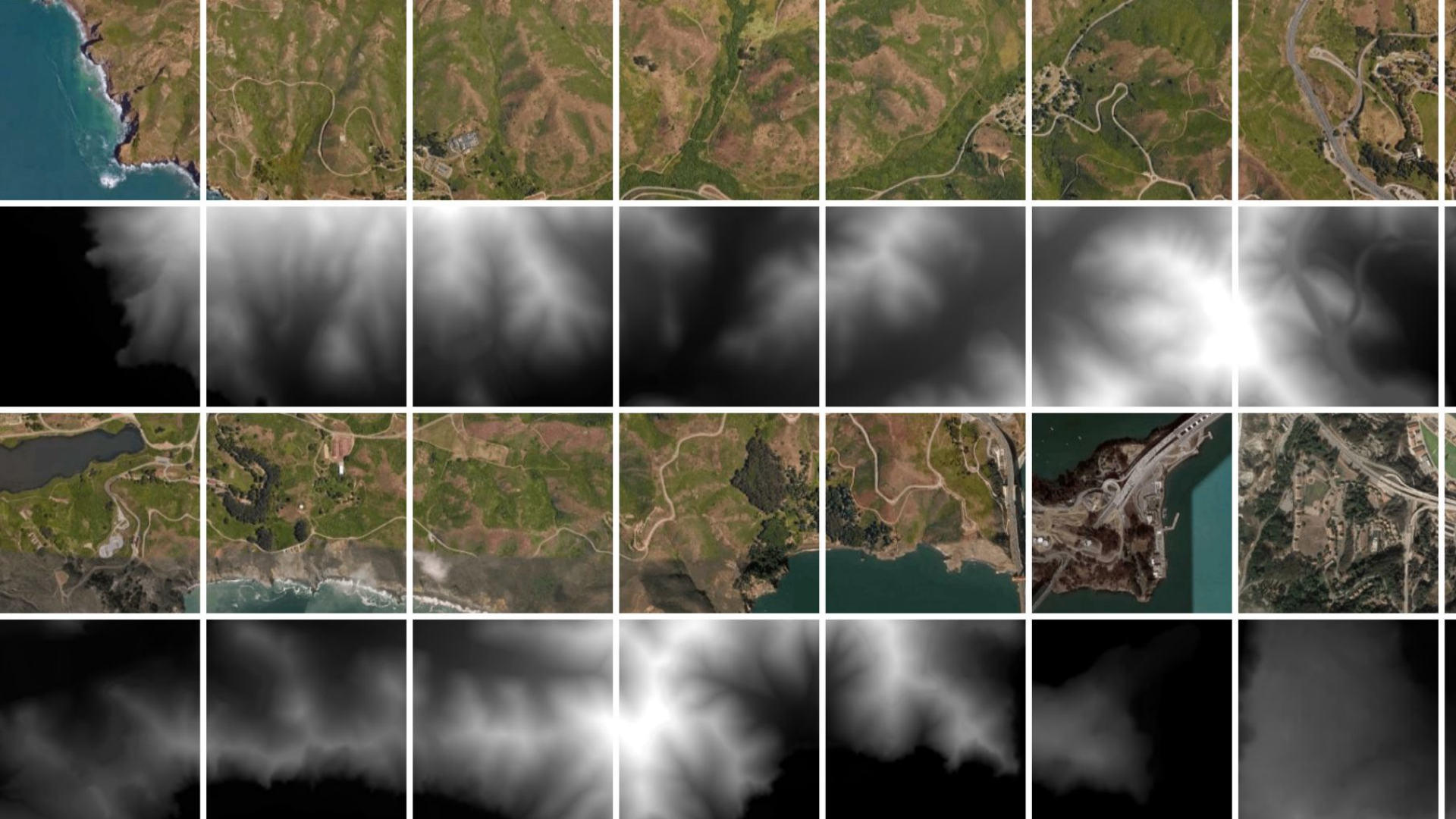
Linear

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


Training the
GAN

Note

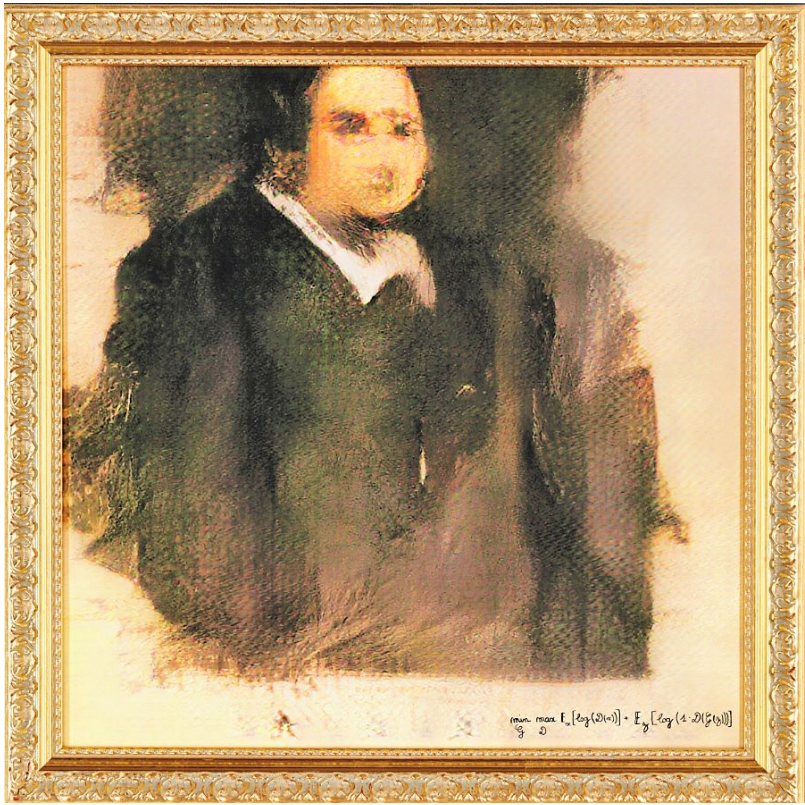
Show GAN code, results and unity models here. Talk about development environment, git, unity, vscode, pipenv, pickle, tensorflow

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.



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.

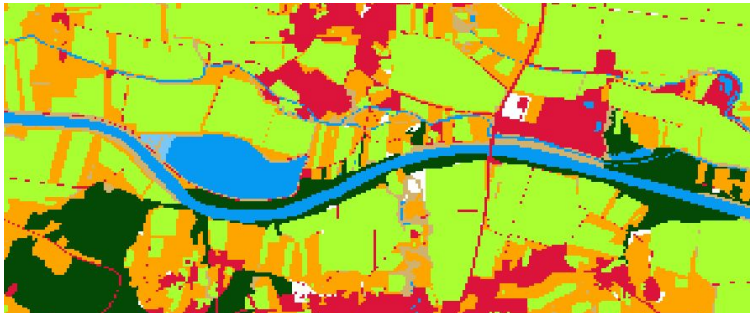
4. **Evidence of Research into Existing Games**
   Although existing games are discussed in this presentation, the evidence behind these points is in the dissertation.

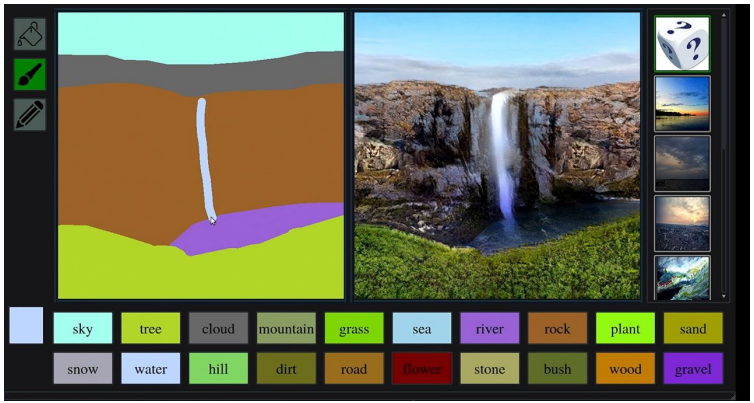
Scope for progression

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.





©GauGAN


Thank you for listening