



**Breaking the boundaries: The Integration of GIS,  
AI, and LiDAR for Digital Innovation.**

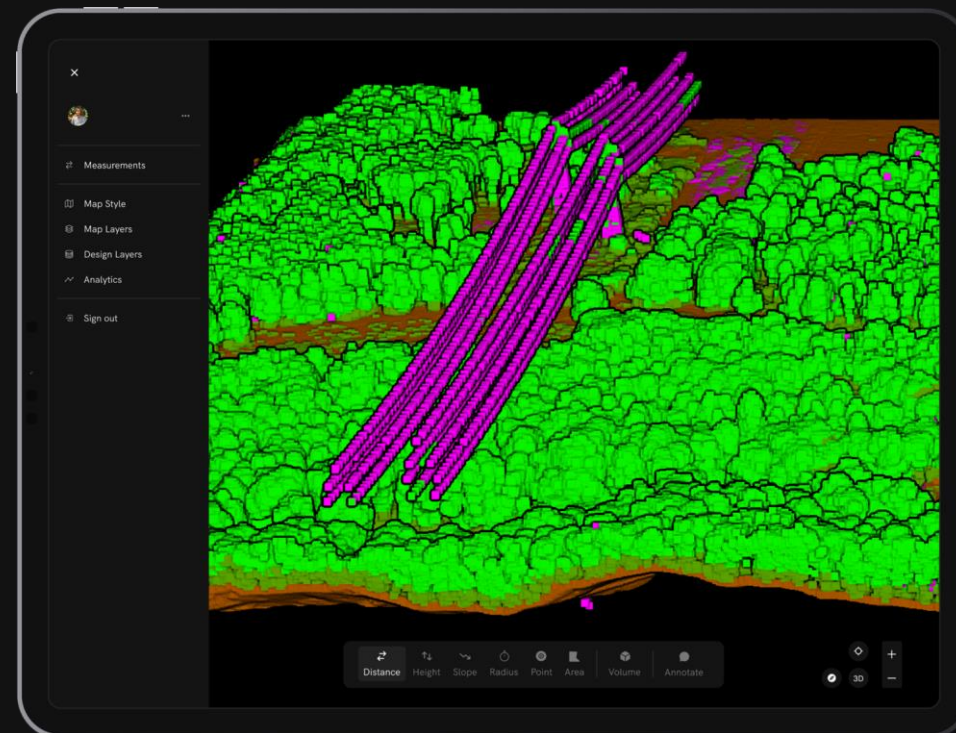


**Hong Tran**  
Founder GIS Engineer

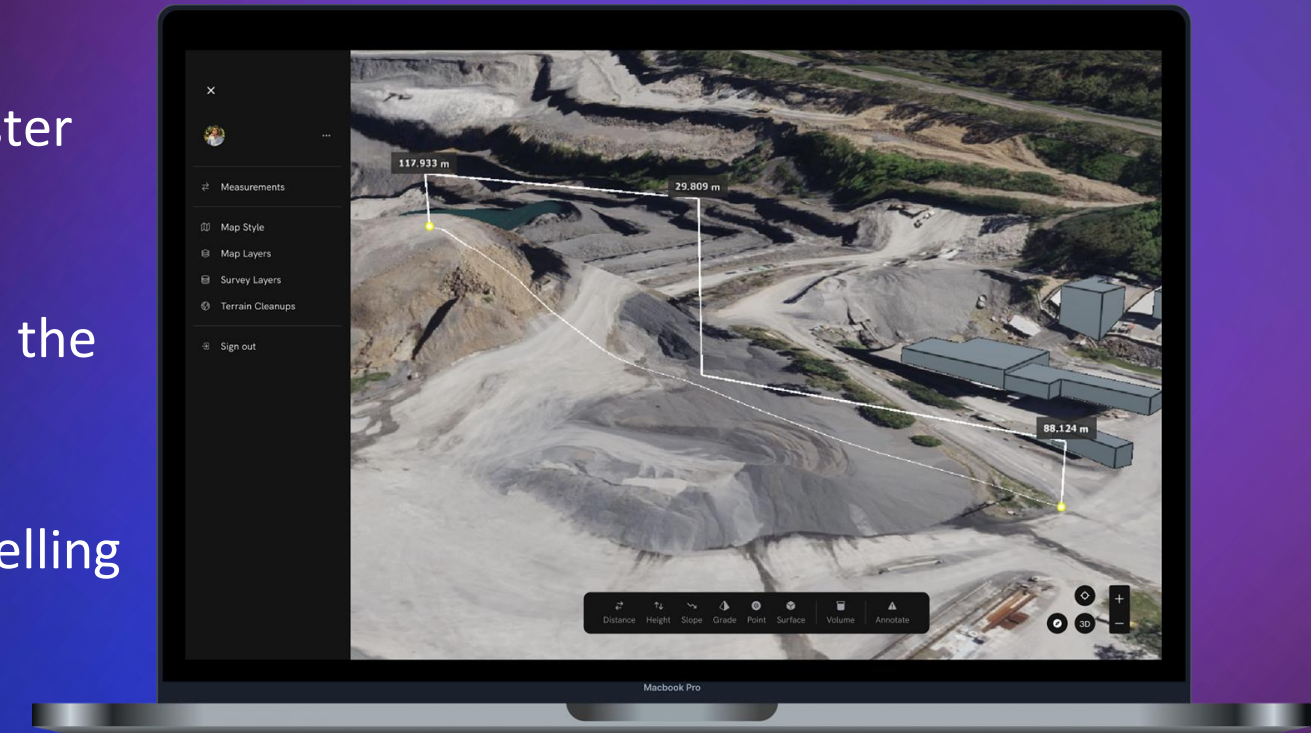




# Agenda



- Time saving techniques for faster processing
- Cleaning the junk caused from the sensors (noise)
- Using various methods for labelling Point Cloud Data



## Insights

Why and Where Lidar is used in GIS?  
Applications and use cases

## Challenges

LiDAR processing using various techniques of Machine Learning and Ai

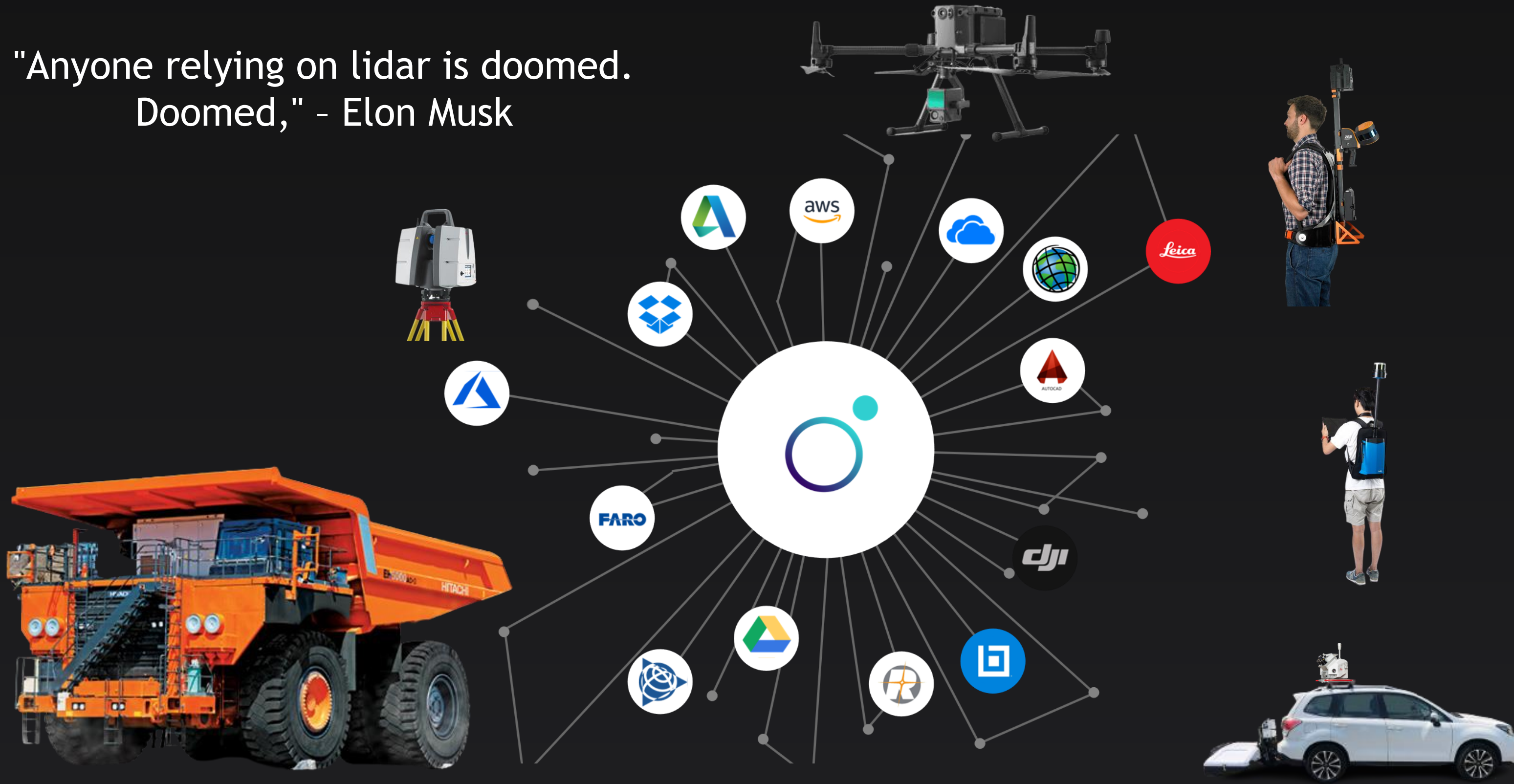
## Interoperability

Fusing the results for GIS ready applications





"Anyone relying on lidar is doomed.  
Doomed," - Elon Musk



# Market Size

The world is changing, Digital Earth is not new. Its GIS.

1

The global digital twin market reached a value of **US\$ 6.75 Billion** in 2021.

2

Expects the market to reach **US\$ 54.6 Billion by 2027**, exhibiting at a CAGR of 31.7% during 2022–2027.

3

By 2030, **millennials will represent 75%** of the US workforce. Trends need to start in this generation.

Sources:

<https://www.fortunebusinessinsights.com/digital-twin-market-106246>

<https://www.imarcgroup.com/digital-twin-market>

<https://www.pwc.com/ug/en/press-room/how-prepared-are-employers-for-generation-z-.html>

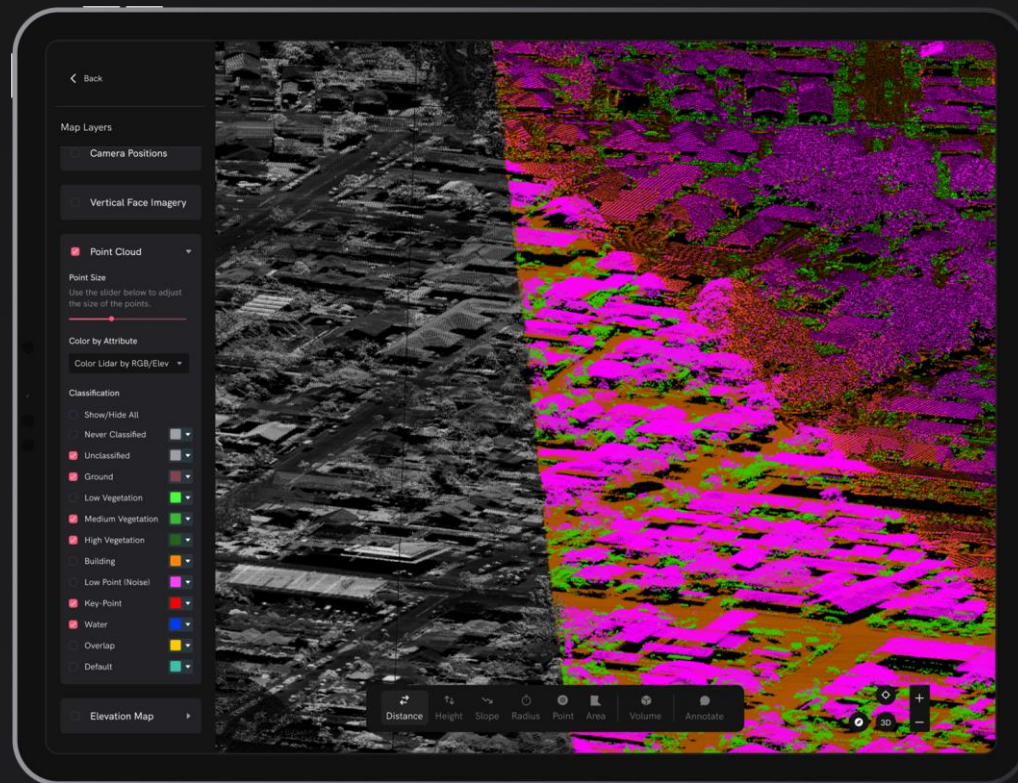




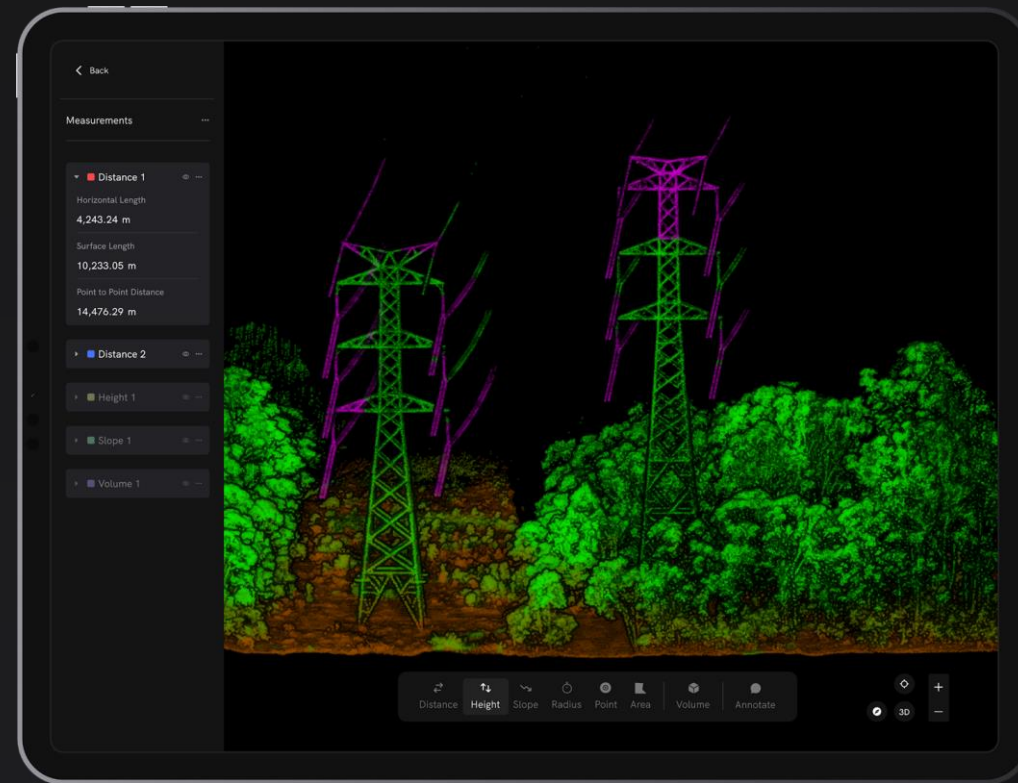
## Why and Where Lidar is used in GIS?

Lidar (Light Detection and Ranging) is a remote sensing technology that uses laser light to measure distances and generate 3D maps of objects and environments.

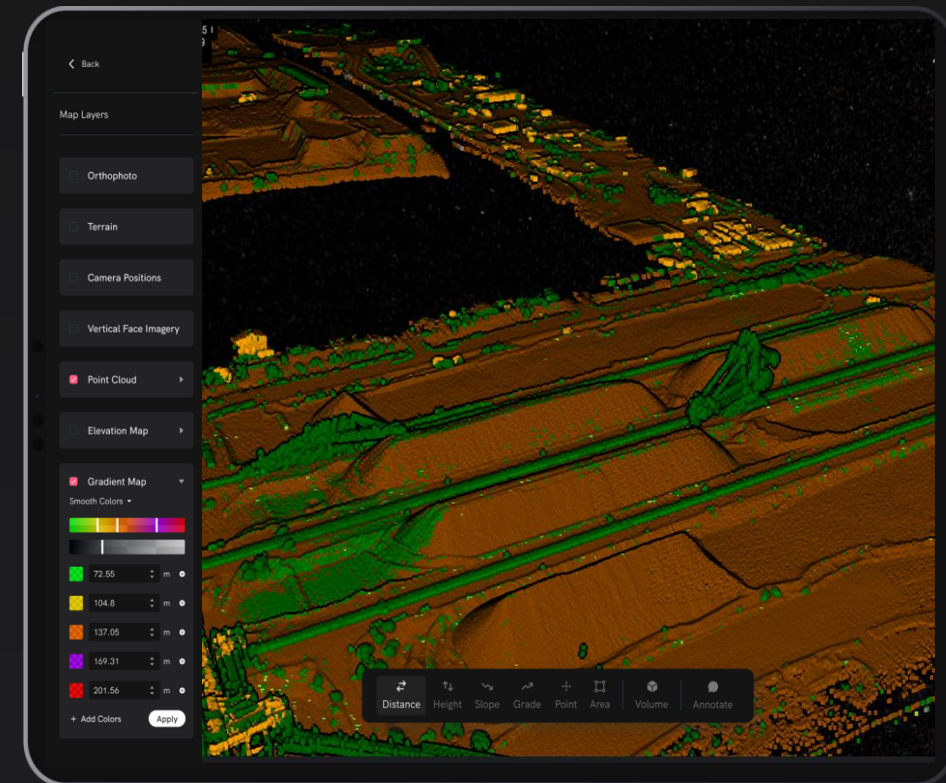
The basic principle of lidar is that it uses laser pulses that bounce off the surfaces of objects and return to a sensor, which measures the time and distance traveled by the light.



Mapping & Environmental



Infrastructure & Construction

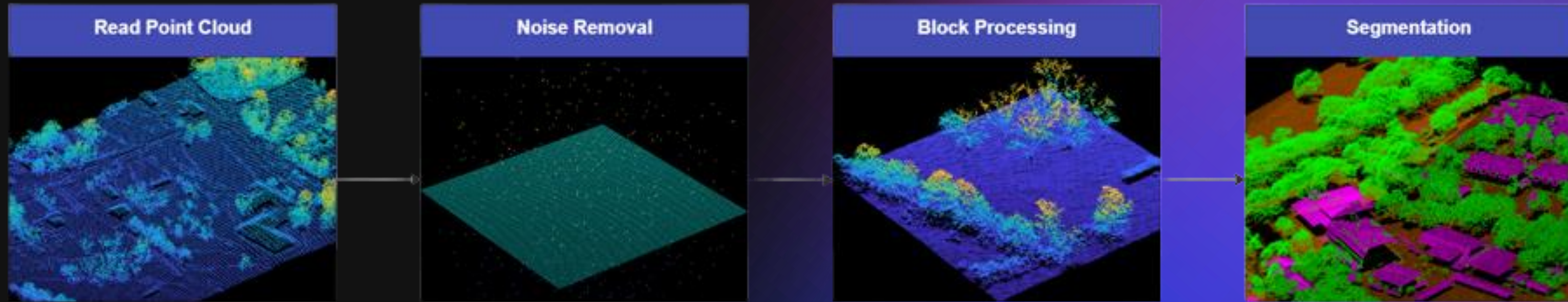


Mining & Surveying





## Time saving Techniques:

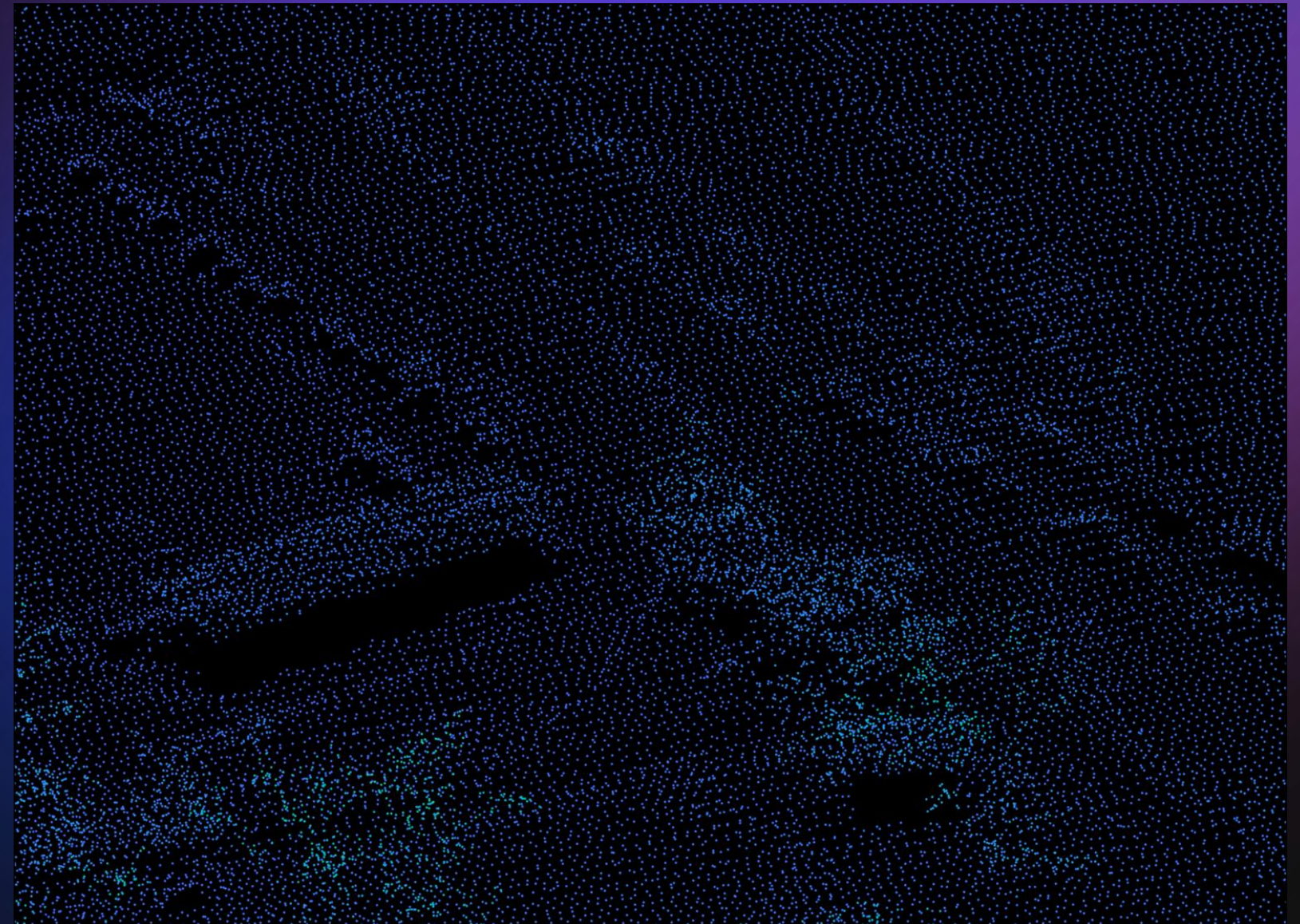
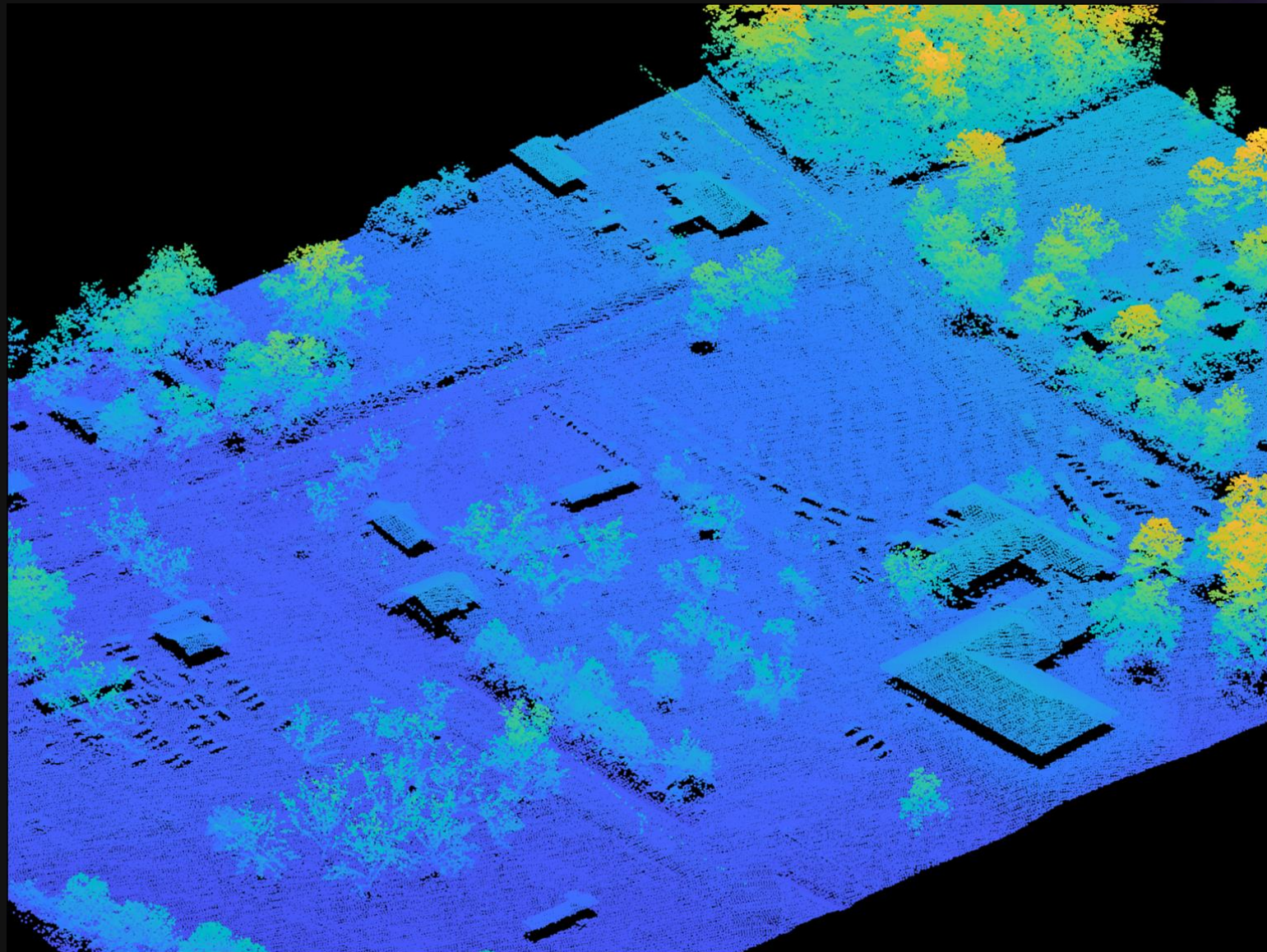


1. Point clouds are really large and processing is memory intensive Use **sub-sampling**.
2. To improve the accuracy and quality of the data. Noise removal is an important step in both decreasing processing time and improving the results.
3. You can eat an elephant one bite at a time. Do the same with large point clouds, by using tiling you divide it into smaller blocks.



## Time saving Techniques : What is Subsampling.

**Sub-sampling Technique:** This reduces the number of points in the point cloud while preserving its overall structure. This can significantly reduce processing time and memory usage. **MATLAB** has built-in functions for sub-sampling: **pcdownsample**.





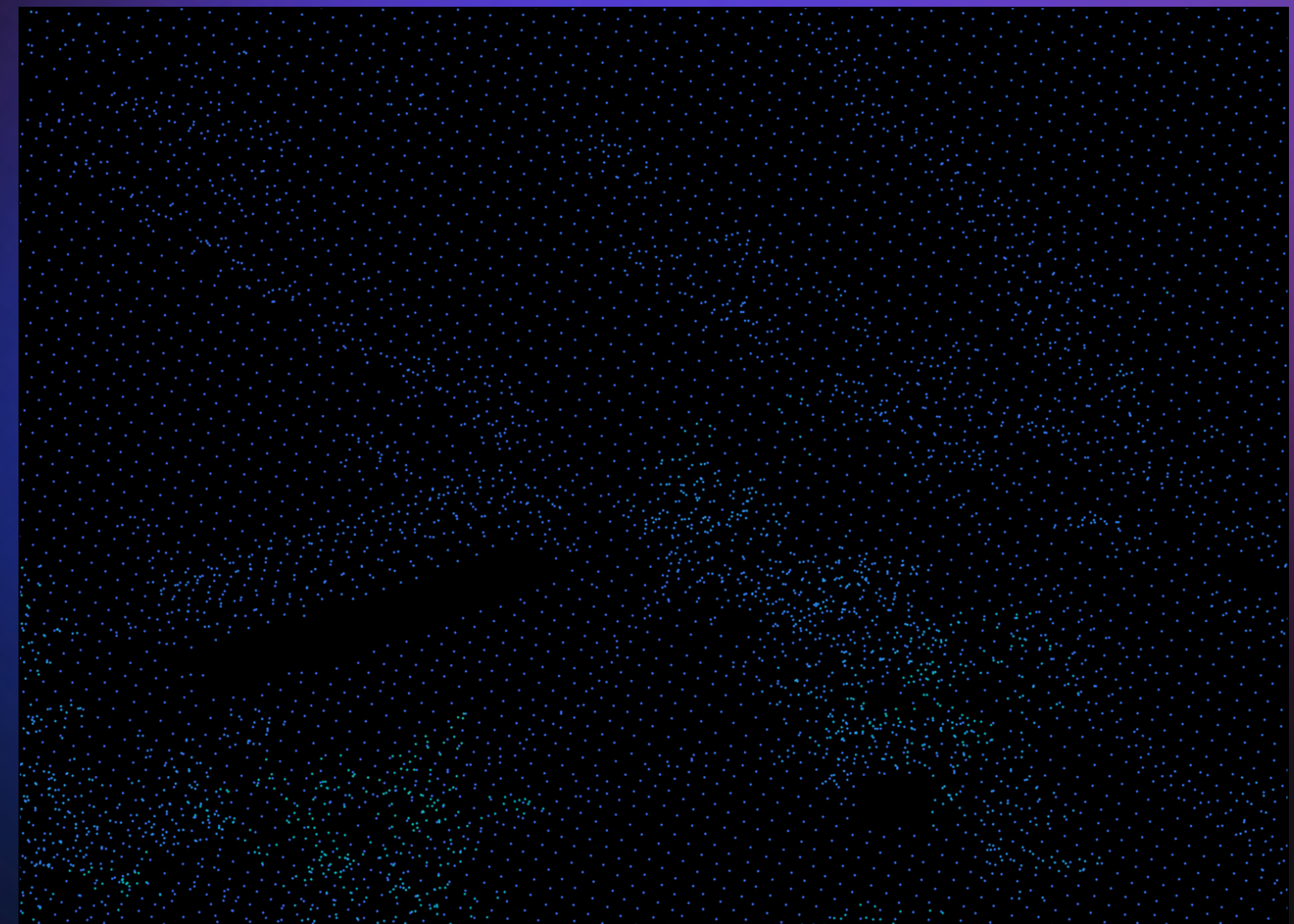
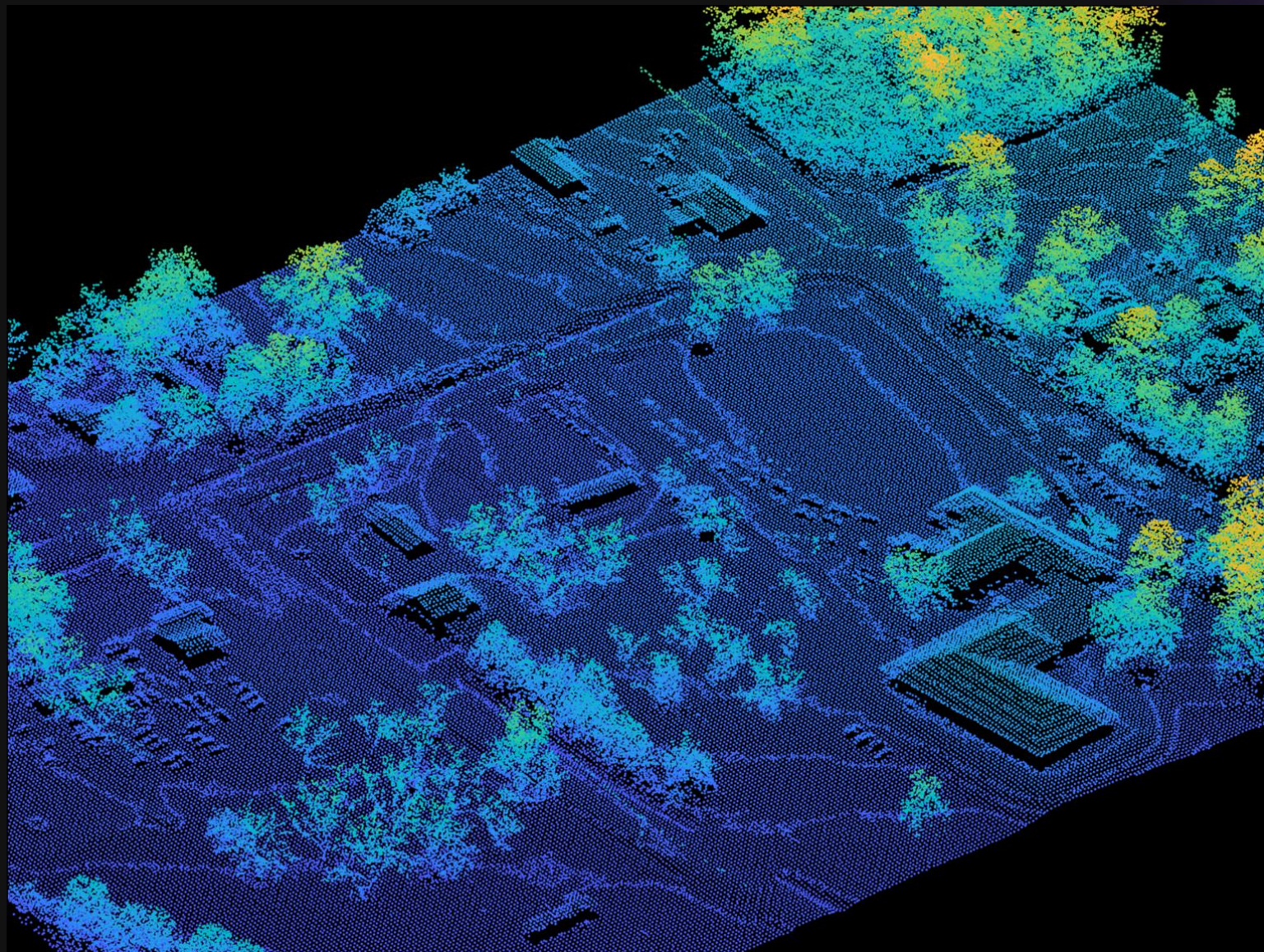
## Time saving Techniques : What is Subsampling.

```
% Load lidar point cloud data  
ptCloud = pcread('lidar_data.pcd');
```

```
% Visualize the original point cloud  
figure;  
pcshow(ptCloud);  
title('Original Point Cloud');
```

```
% Run subsampling with a factor of 0.5  
subsampedPtCloud = pcdownsampling(ptCloud, 'gridAverage', 0.5);
```

```
% Visualize the subsampled point cloud  
figure;  
pcshow(subsampedPtCloud);  
title('Subsampled Point Cloud');
```





## Time saving Techniques : Why remove the noise?

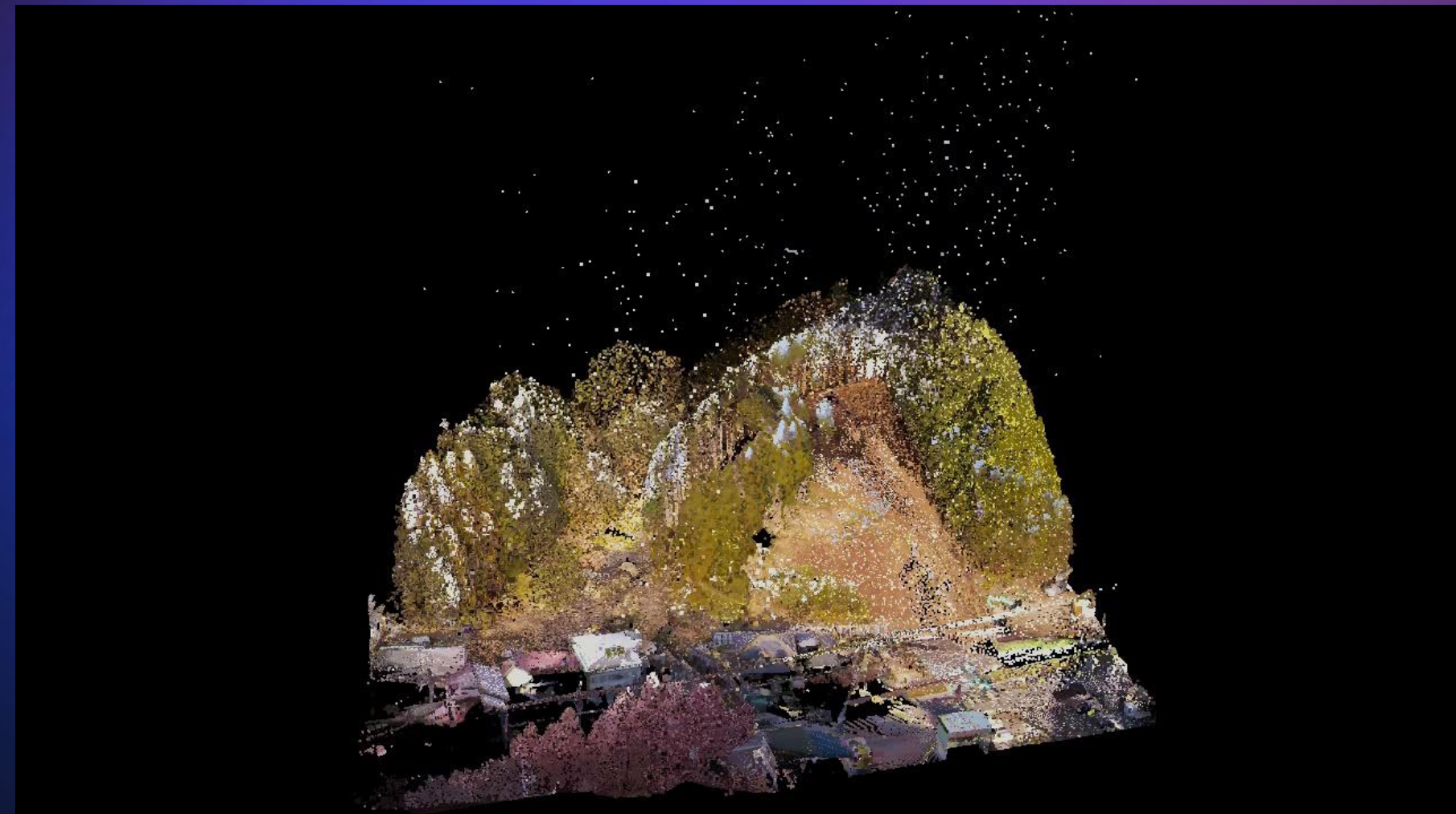
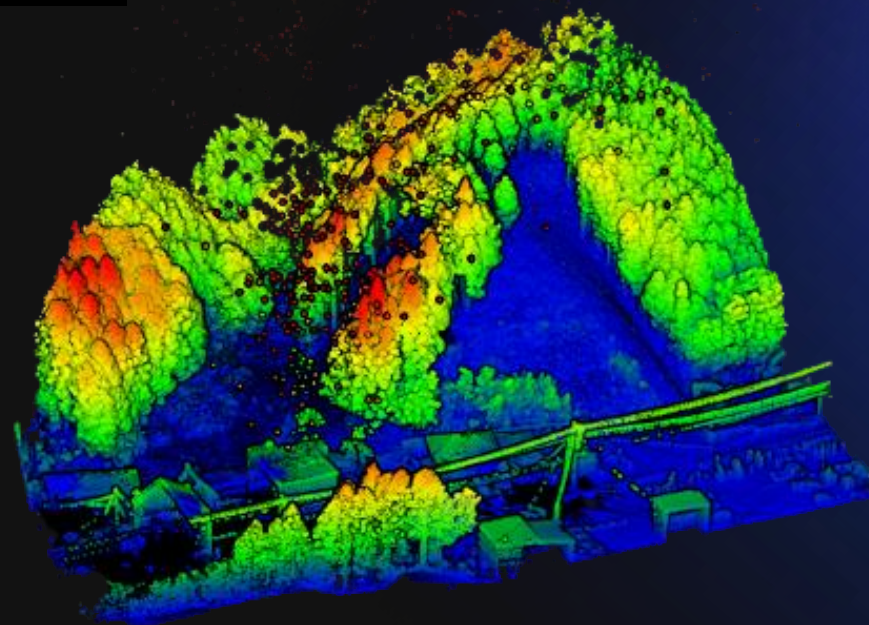
Noise removal is an important step in processing LiDAR point clouds, as it can improve the accuracy and quality of the data. We have successes in using **pcdenoise**

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```

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```

```
% Run pcdenoise on the point cloud data with a noise filter of 0.1  
ptCloud = pcdenoise(ptCloud, 'NumNeighbors', 5, 'Threshold', 0.1);
```

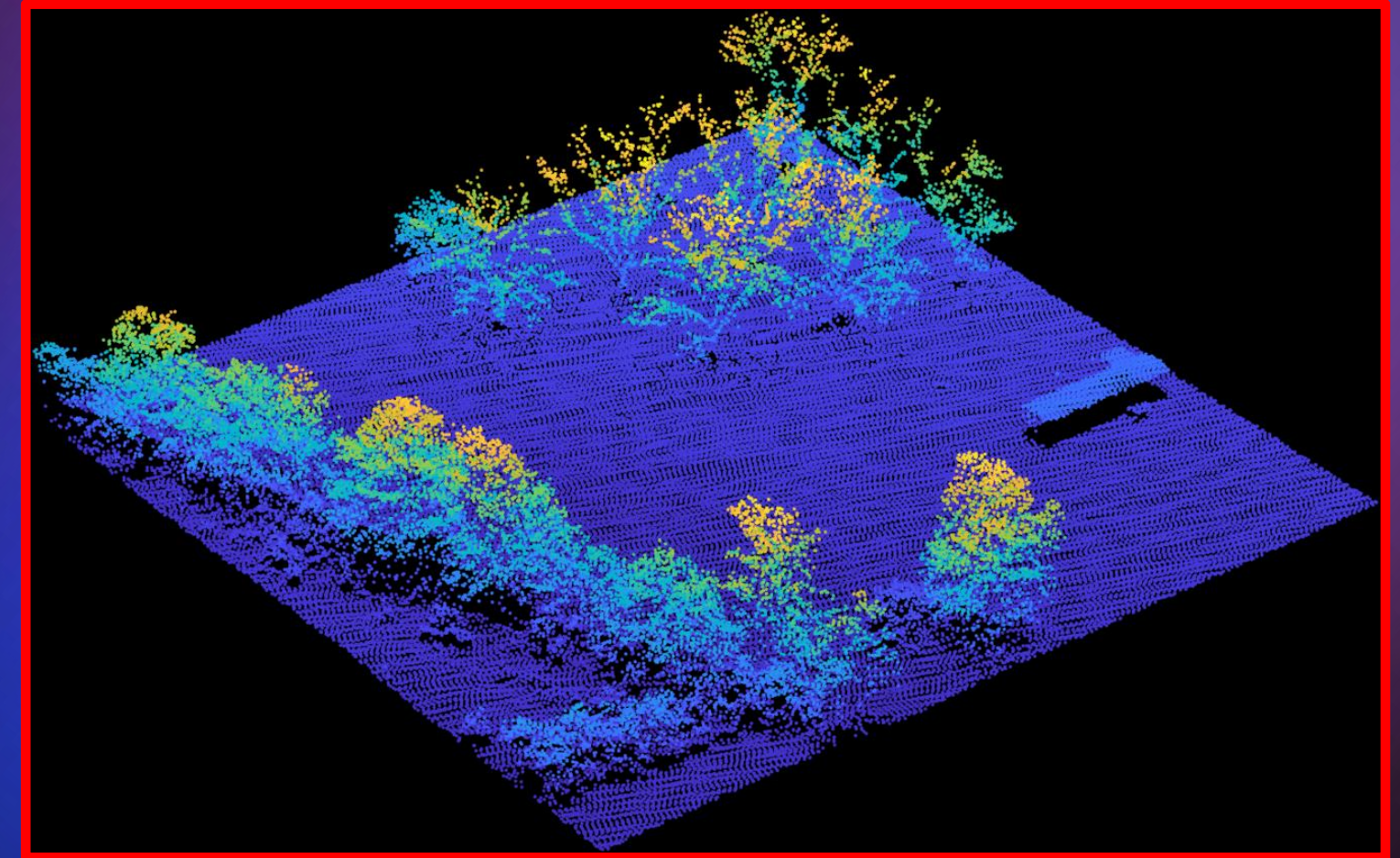
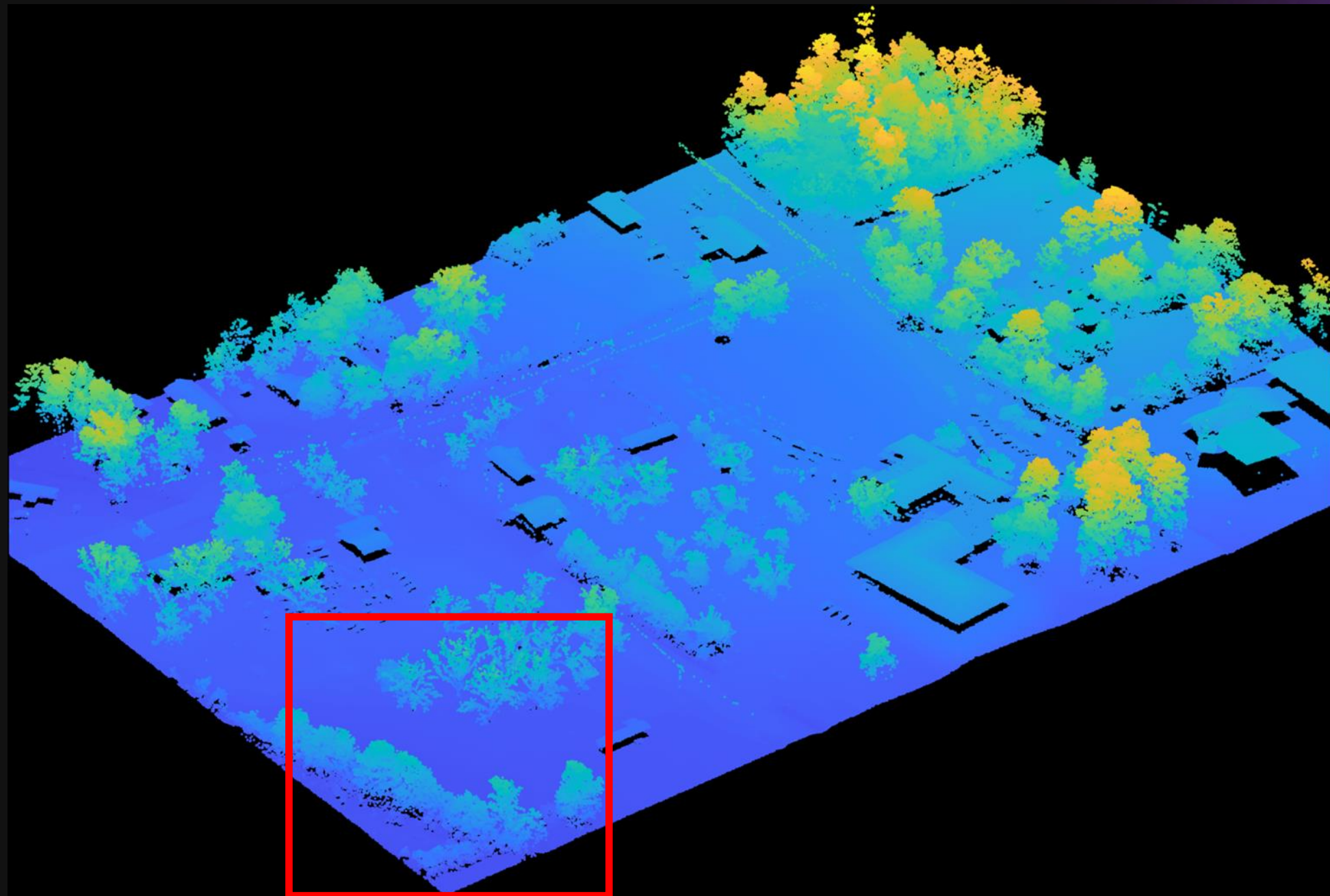
```
% Visualize the denoised point cloud  
figure;  
pcshow(ptCloud);  
title('Denoised Point Cloud');
```





## Time saving Techniques : Why do we need to Block process?

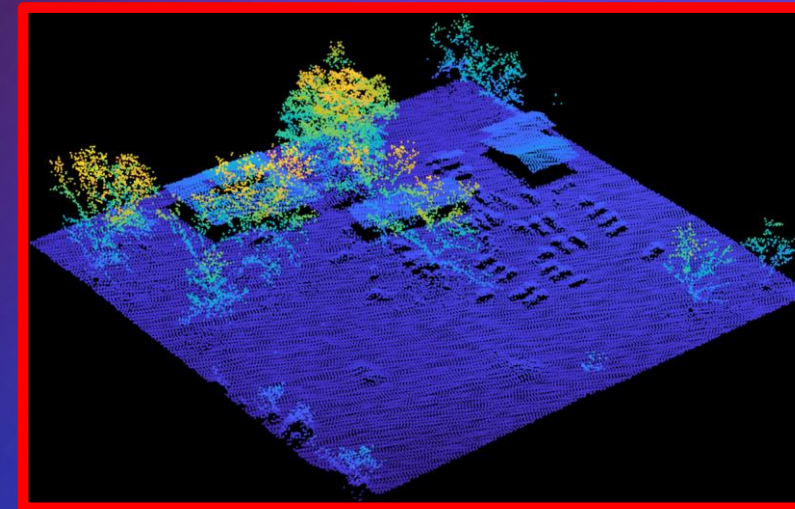
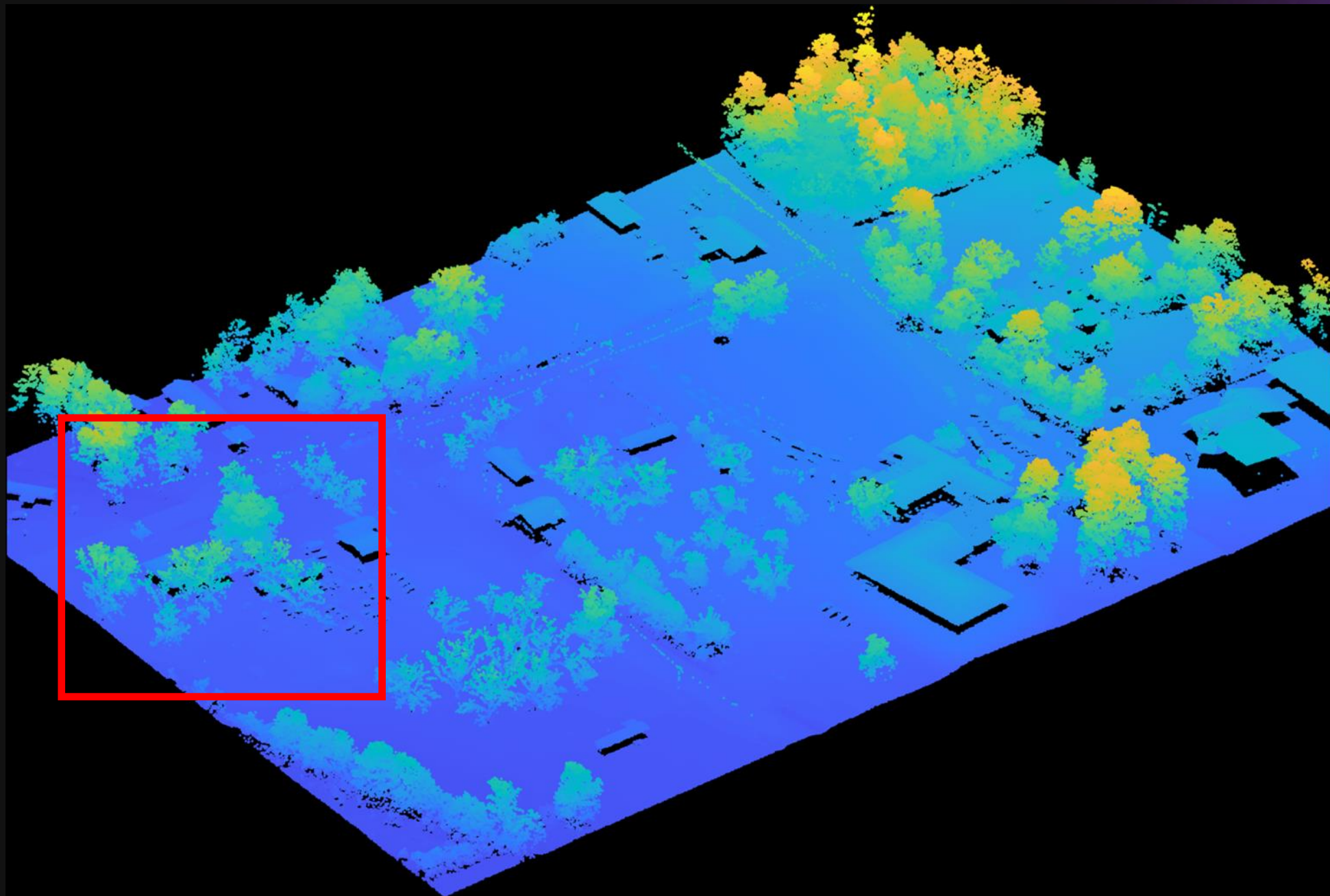
Block the large datasets into smaller tiles. Blocking a point cloud means dividing it into smaller blocks or chunks, which can be processed individually to reduce memory usage.





## Time saving Techniques : Why do we need to Block process?

Block the large datasets into smaller tiles. Blocking a point cloud means dividing it into smaller blocks or chunks, which can be processed individually to reduce memory usage.



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ptCloud = pcread('lidar_data.pcd');
```

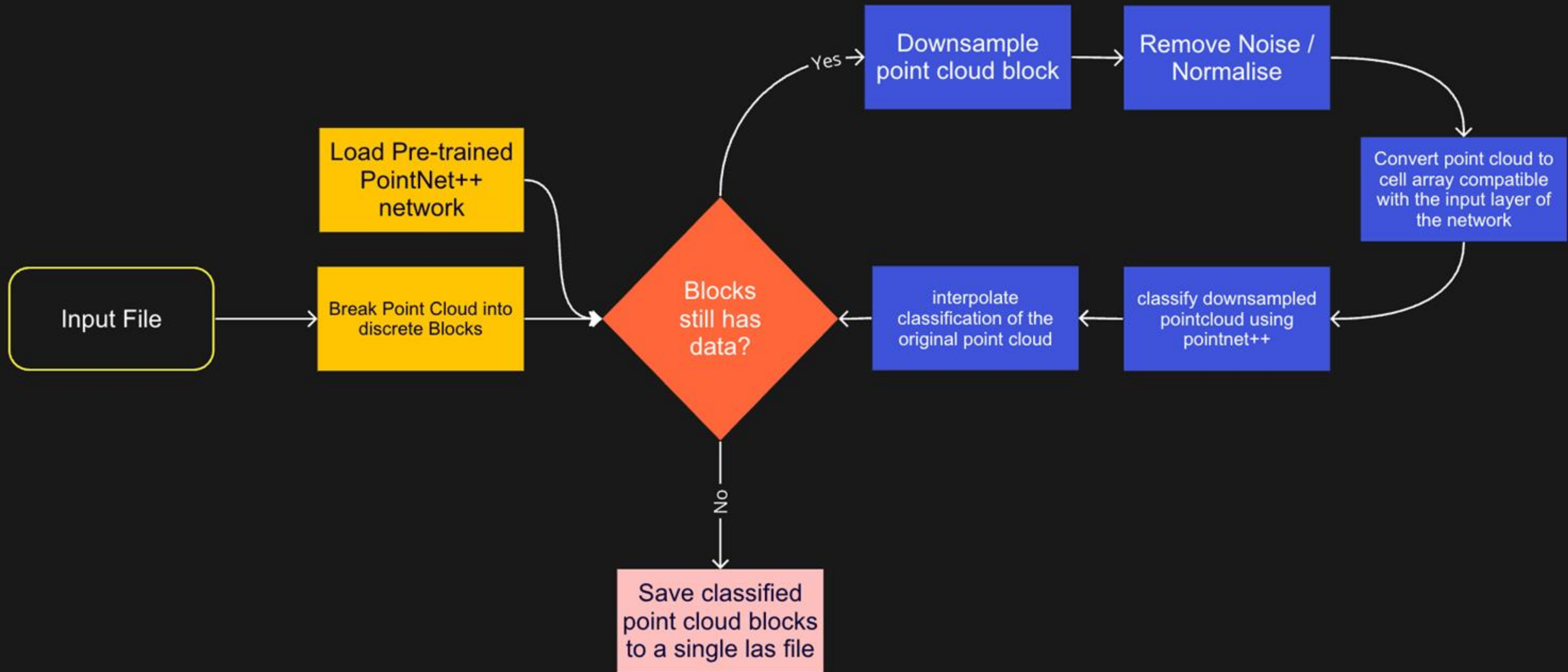
```
% Set the block size to 5 meters  
blockSize = 5;
```

```
% Perform block tiling on the point cloud  
tiledPtCloud = pcblockmerge(ptCloud, 'BlockSize',  
[blockSize blockSize blockSize]);
```

```
% Visualize the tiled point cloud  
pcshow(tiledPtCloud);  
title('Tiled Point Cloud');
```



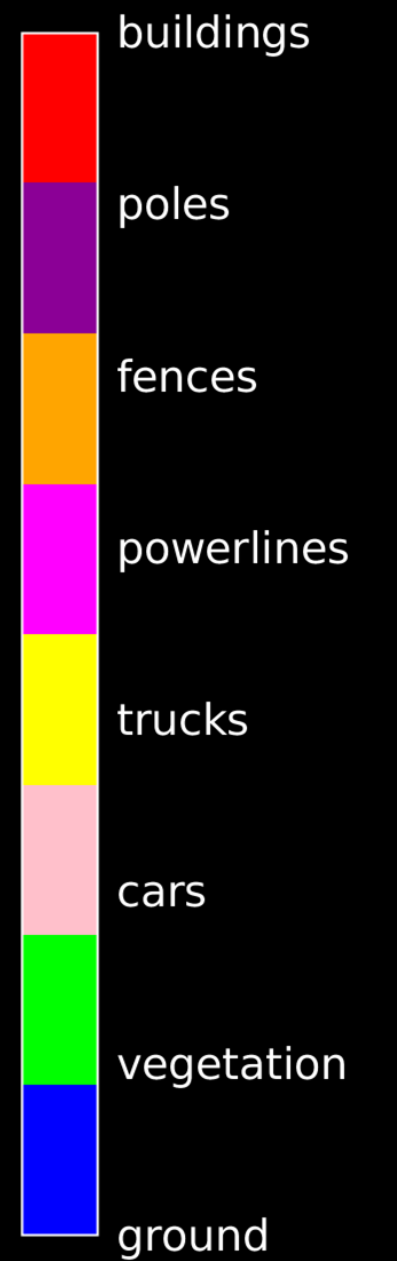
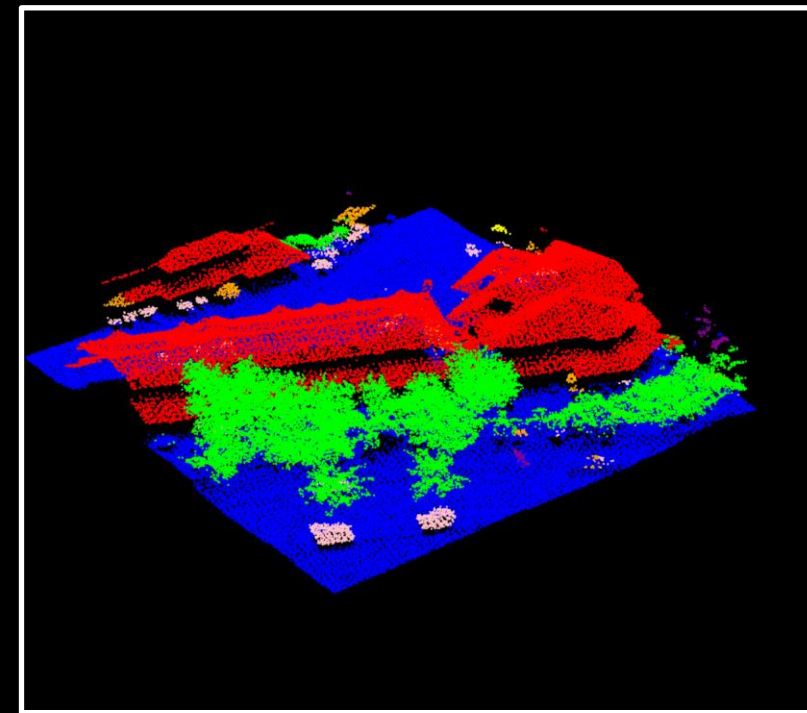
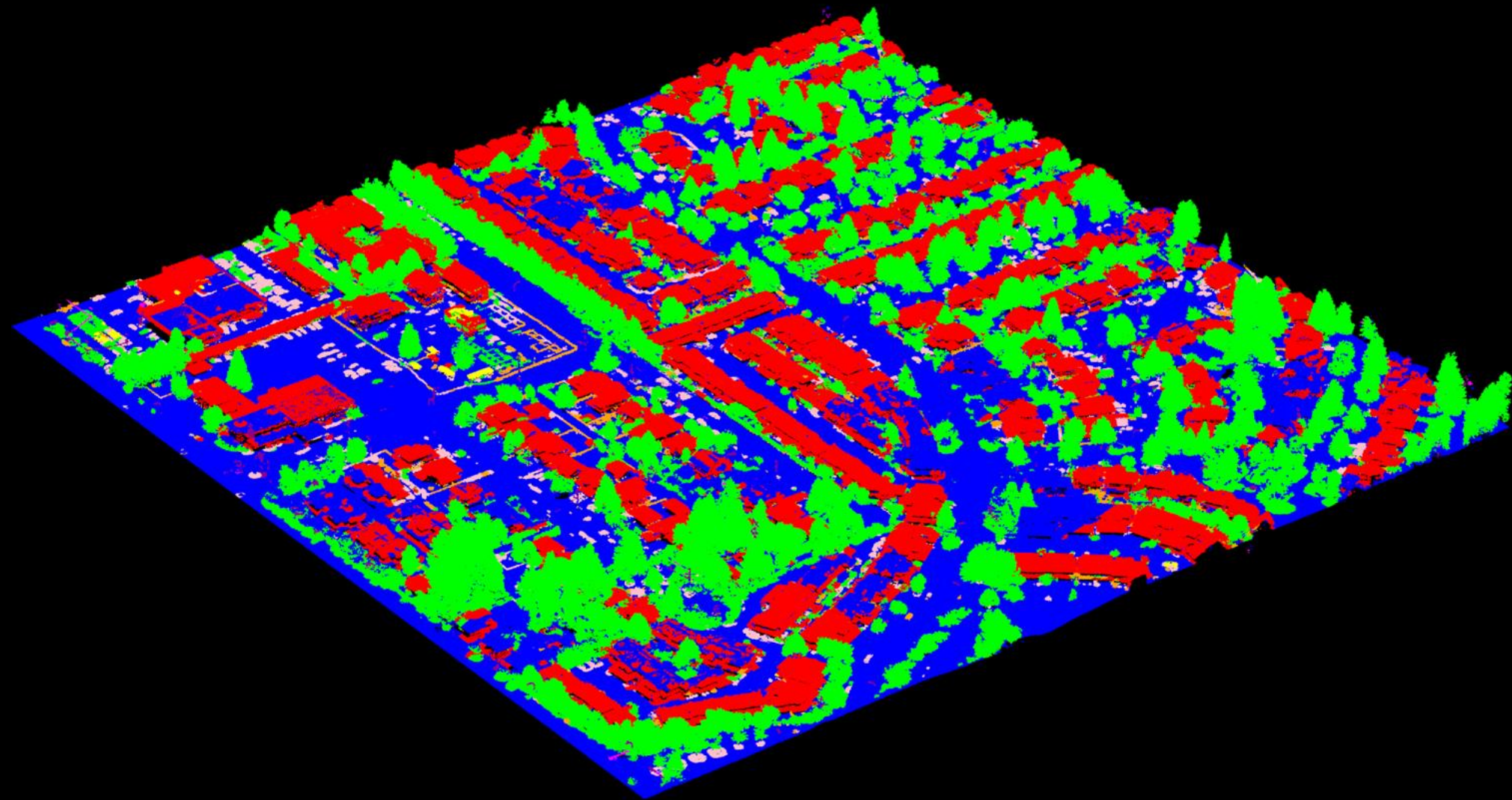
# Lidar segmentation solution : How can we use PointNet++ ?





## Lidar segmentation solution : How can we use PointNet++ ?

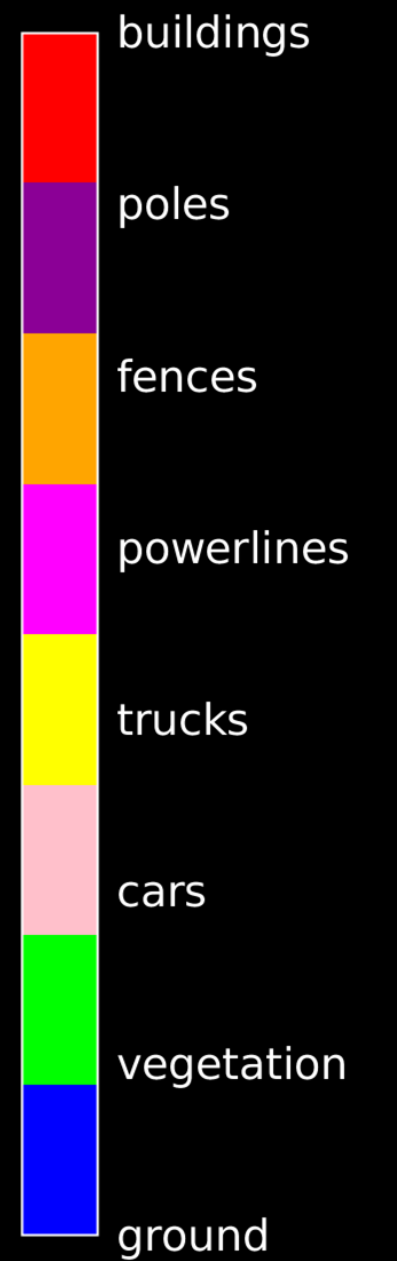
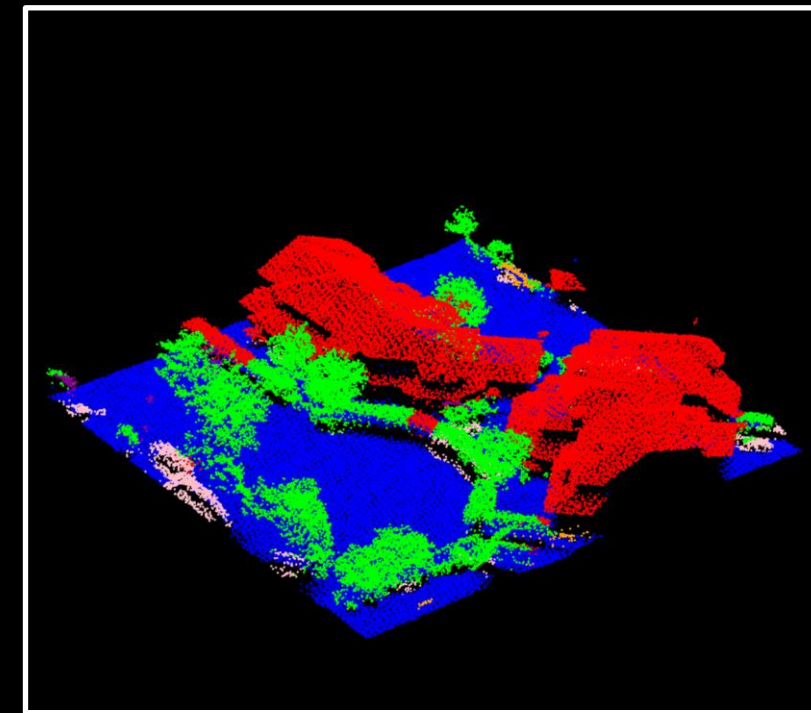
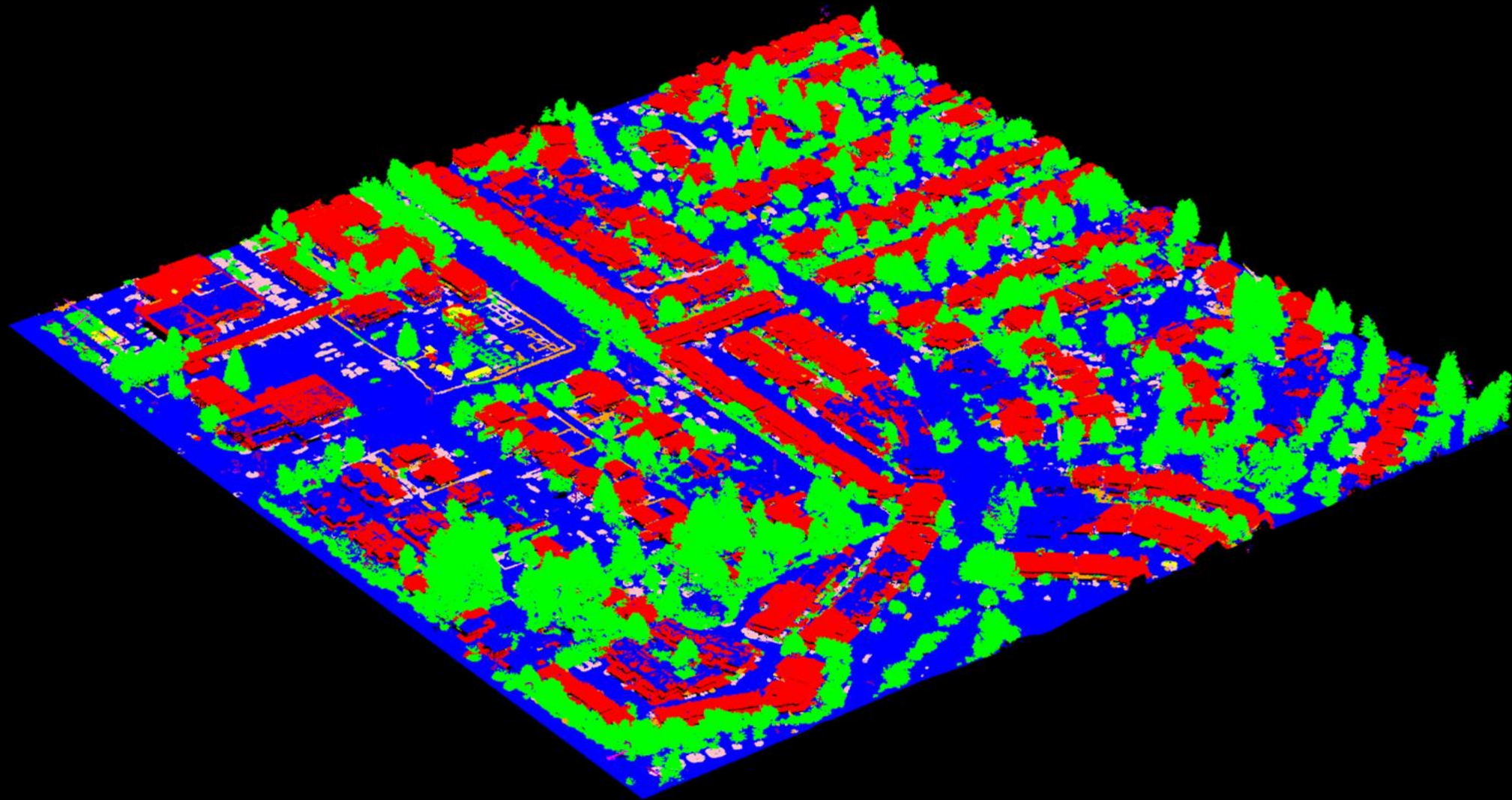
This will enable Multicore and Multi-batch processing (Limit will be RAM and HDD speeds)





# Lidar segmentation solution : How can we use PointNet++ ?

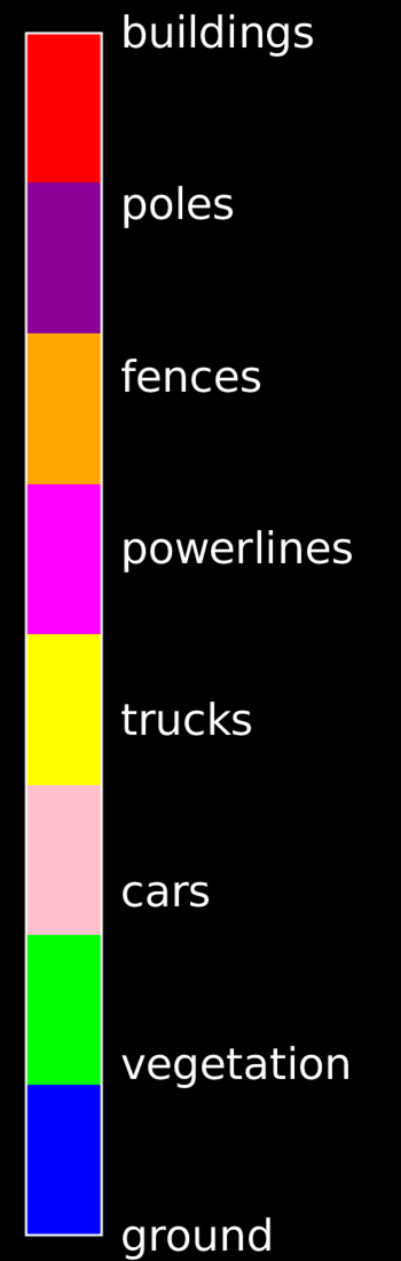
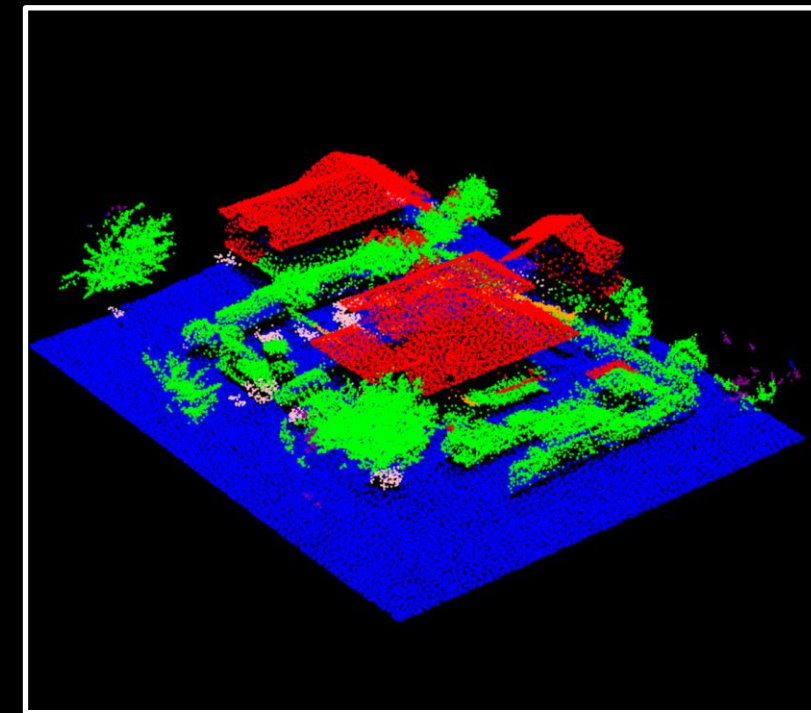
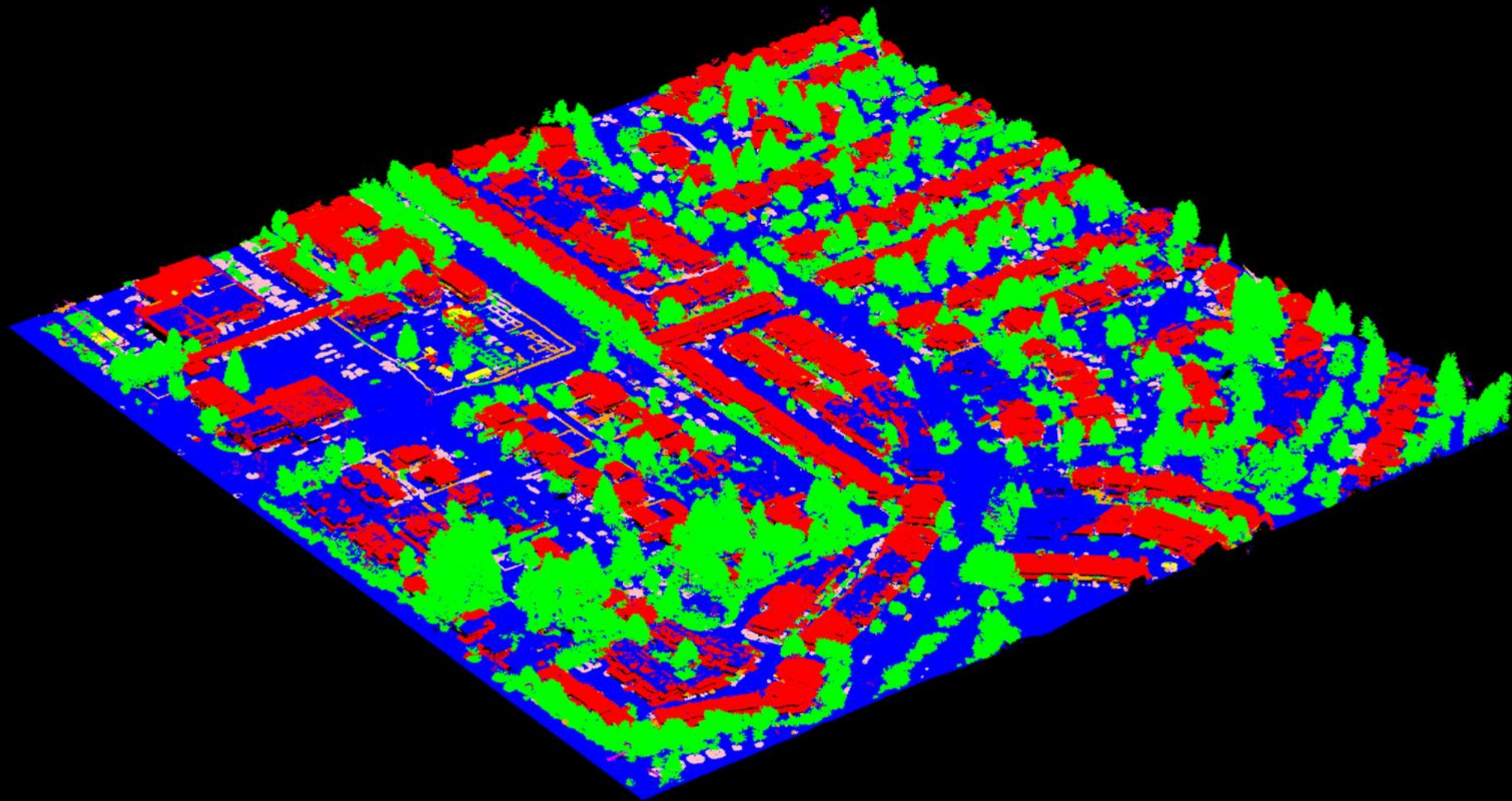
Files can be left as tiles or merged





## Lidar segmentation solution : How can we use PointNet++ ?

We can apply this concept with all different types of point cloud data





## What are the challenges of Lidar segmentation?

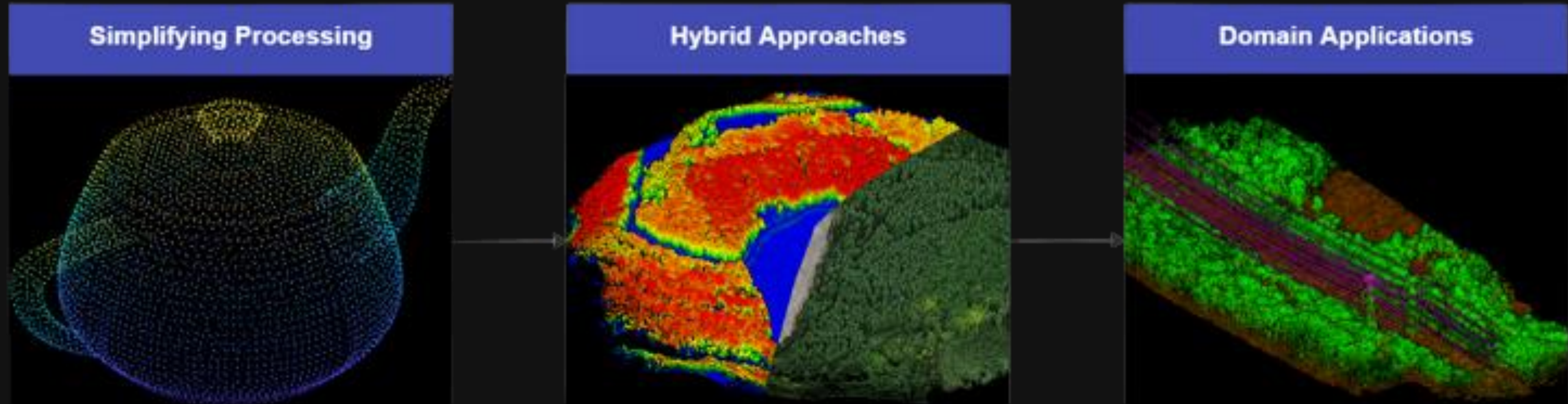
**Trends:** To use rule based segmentation and manually classify.

- Very difficult to develop segmentation based on specific environments. Replicate different environment scenarios is hard to predict.
- Lidar can come from many sensors, so hard coding from hardware is difficult
- High effort to re-code based on a combination of hardware + environment





## Summary and Applications



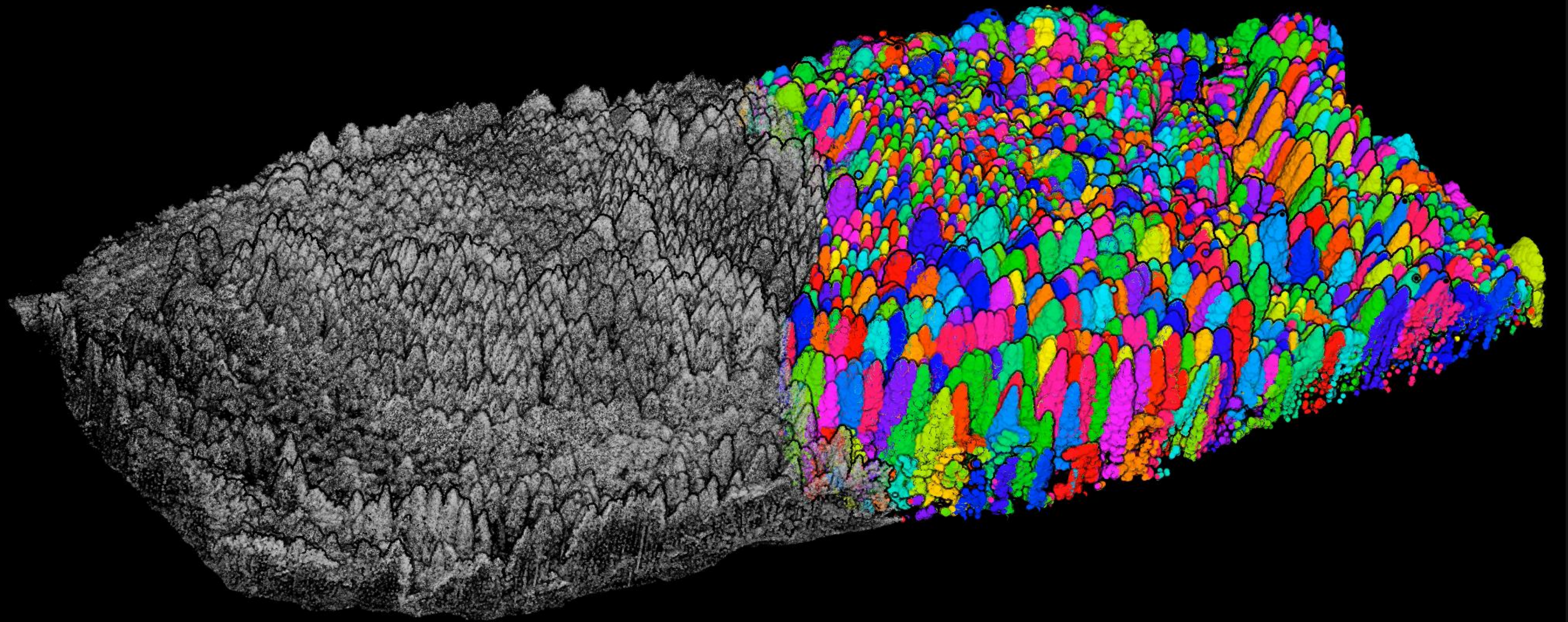
There is **no** 1 key solution for all of this and there is no button that can Ai everything

From our learnings;

1. Keeping it really **simple**. ML and Ai consume a lot of compute power and it is very costly if you don't do the preprocessing.
2. We believe it is a **hybrid** approach, you need to use the right tools for the right job. You cannot just blanket Ai on all point clouds and expect a instant prefect result
3. **Domain experts** are valuable. These people need to apply their field knowledge in code so it gives the function the best chance to perform to its best.

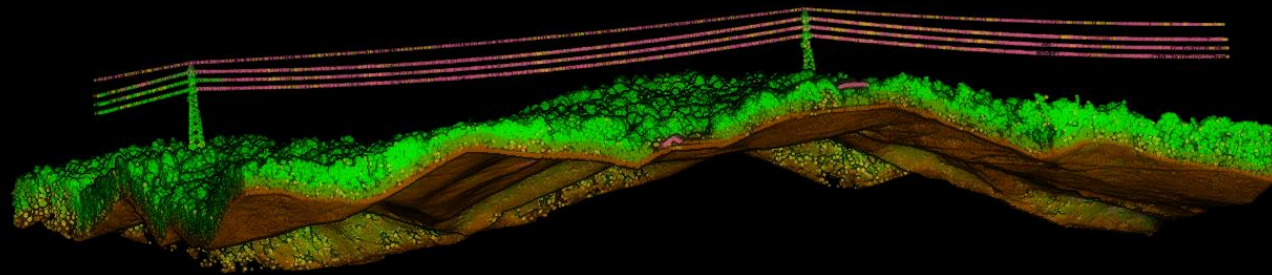
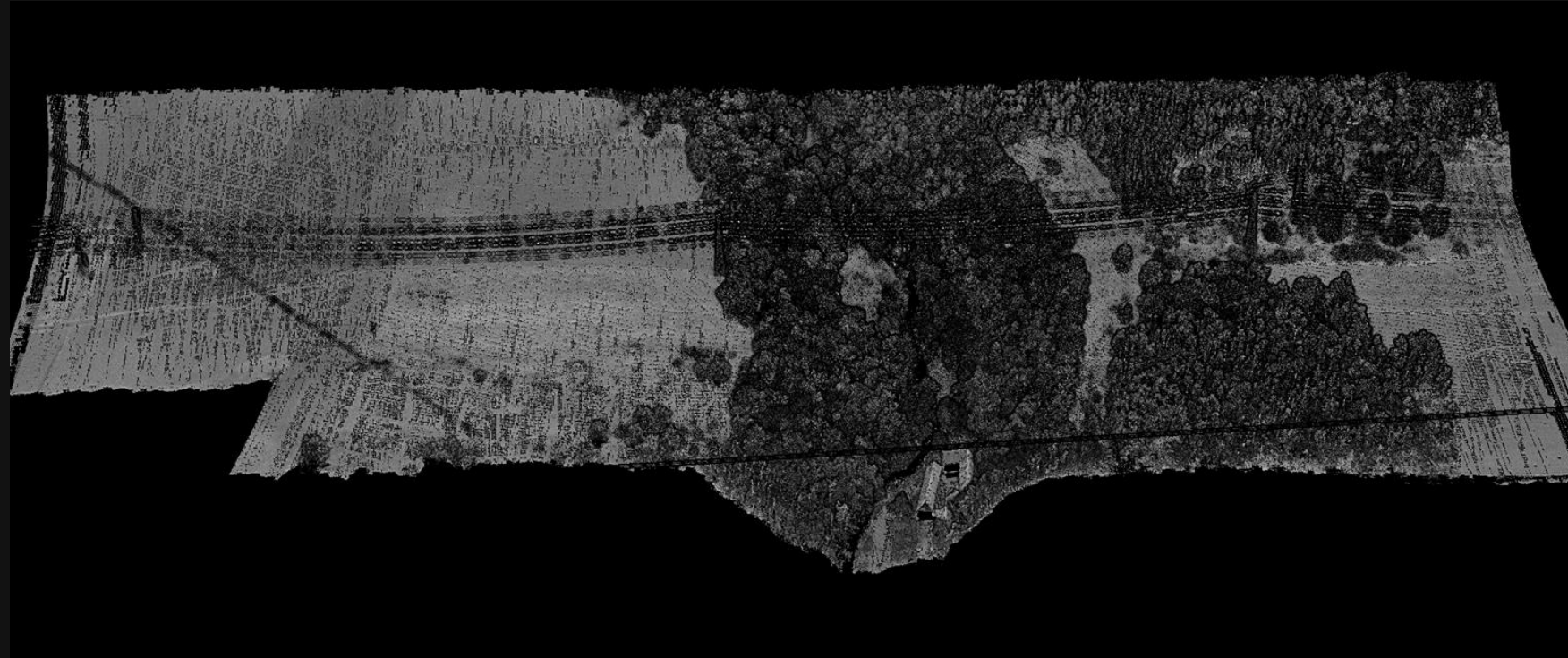


## Forestry & Carbon Management

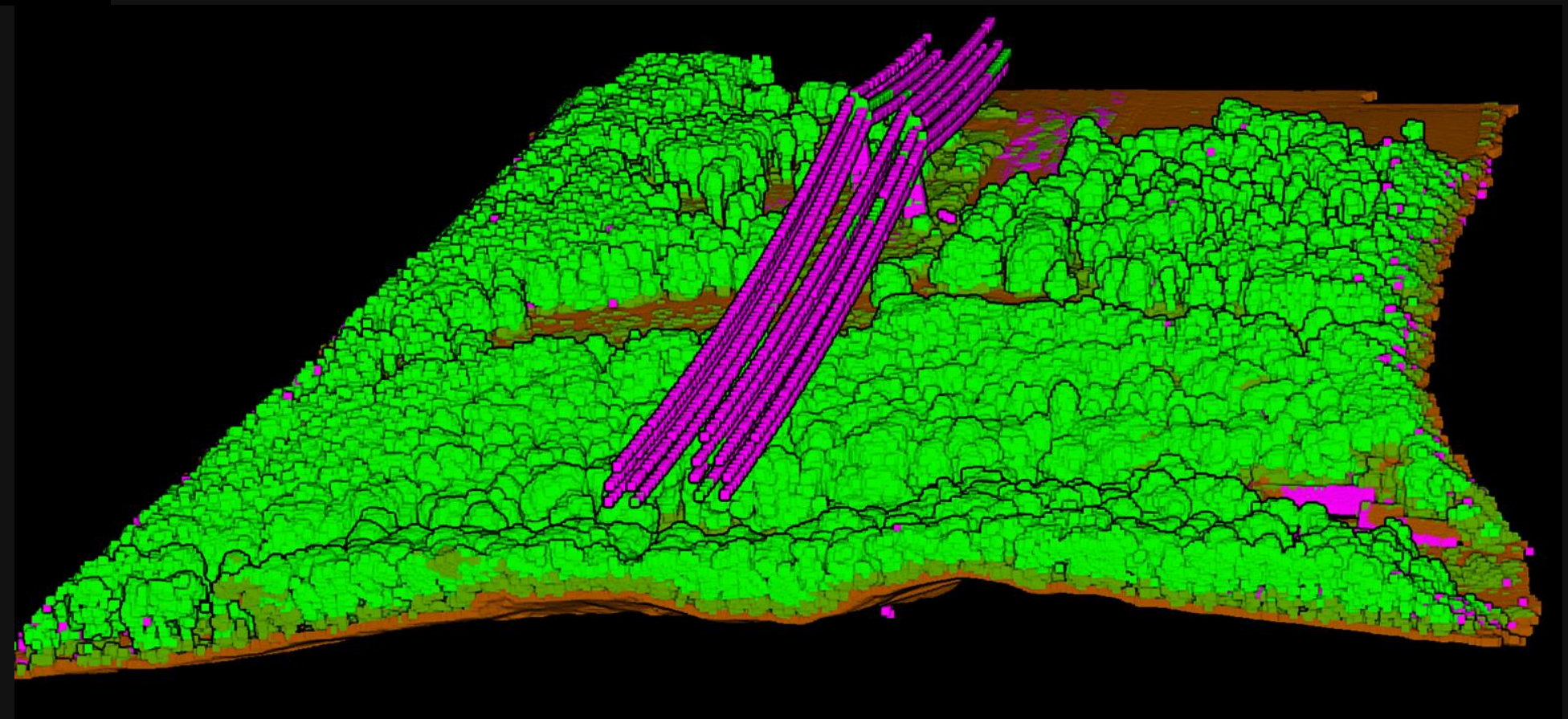




# Powerline & Infrastructure Analysis

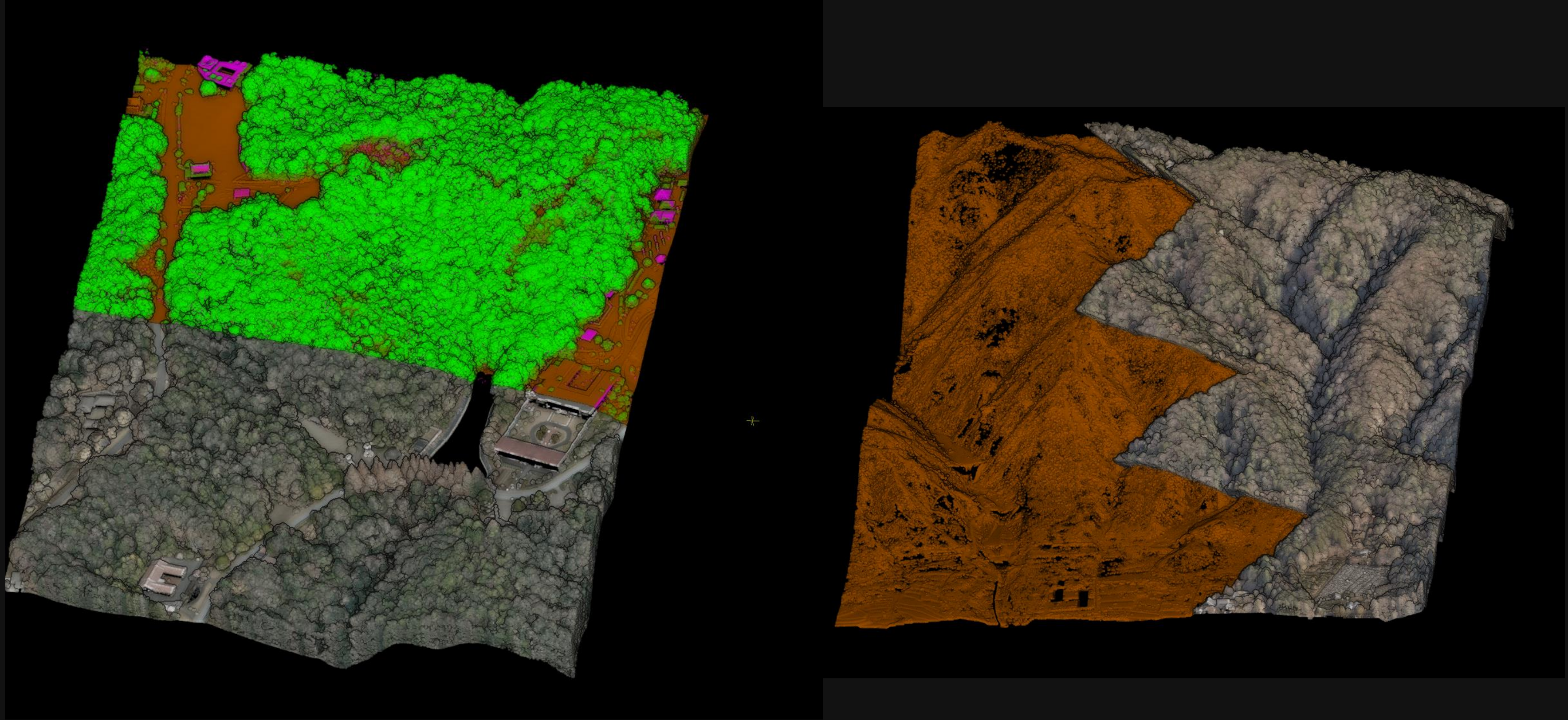


```
Command Prompt
INFO : end time - 20:20:51
INFO : processing time 1.1379 mins (68.2756 secs)
(20:20:53.67) C:\Program Files\Spacesium\spacetools\v1_2_0\application>
(20:20:53.67) C:\Program Files\Spacesium\spacetools\v1_2_0\application>
```



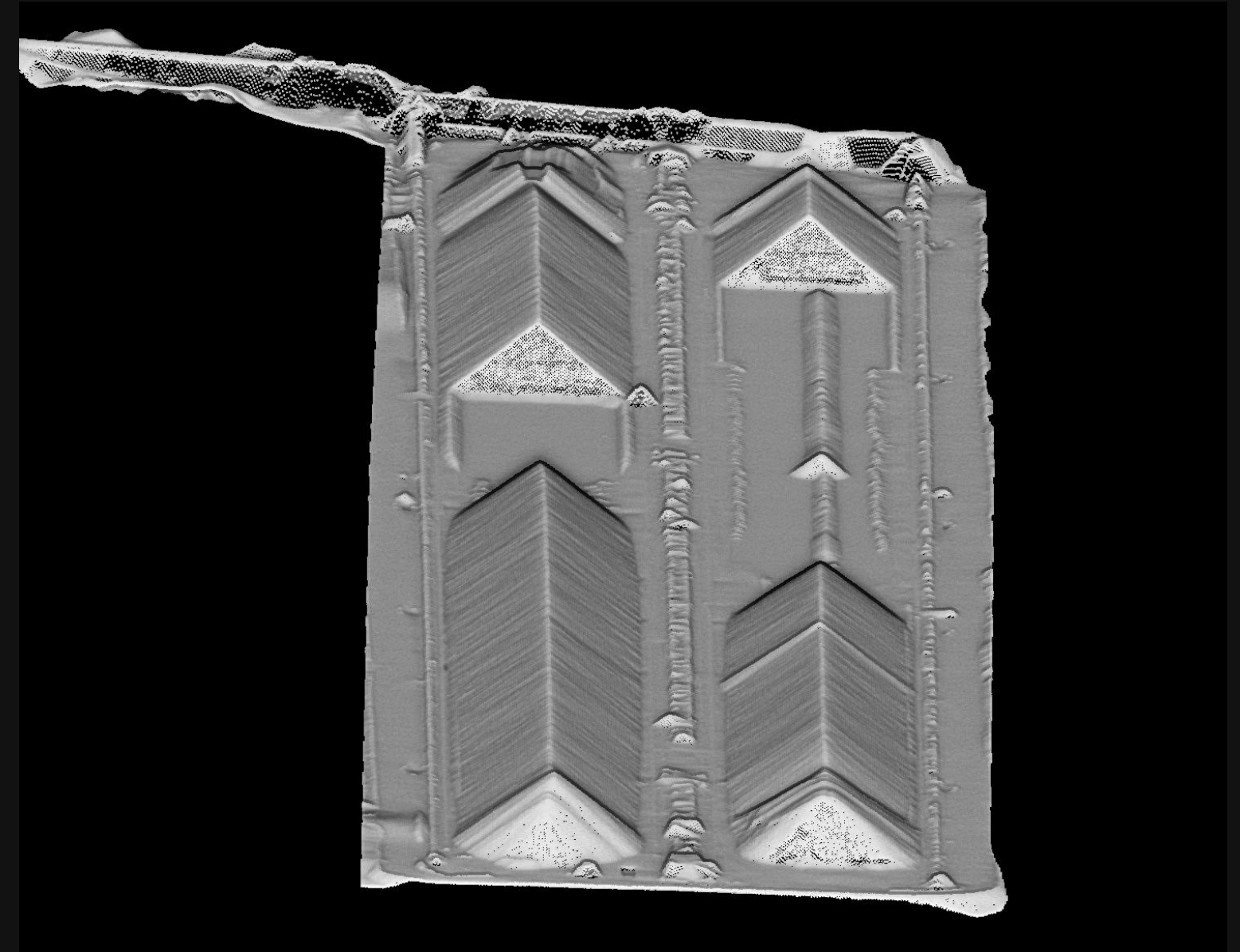
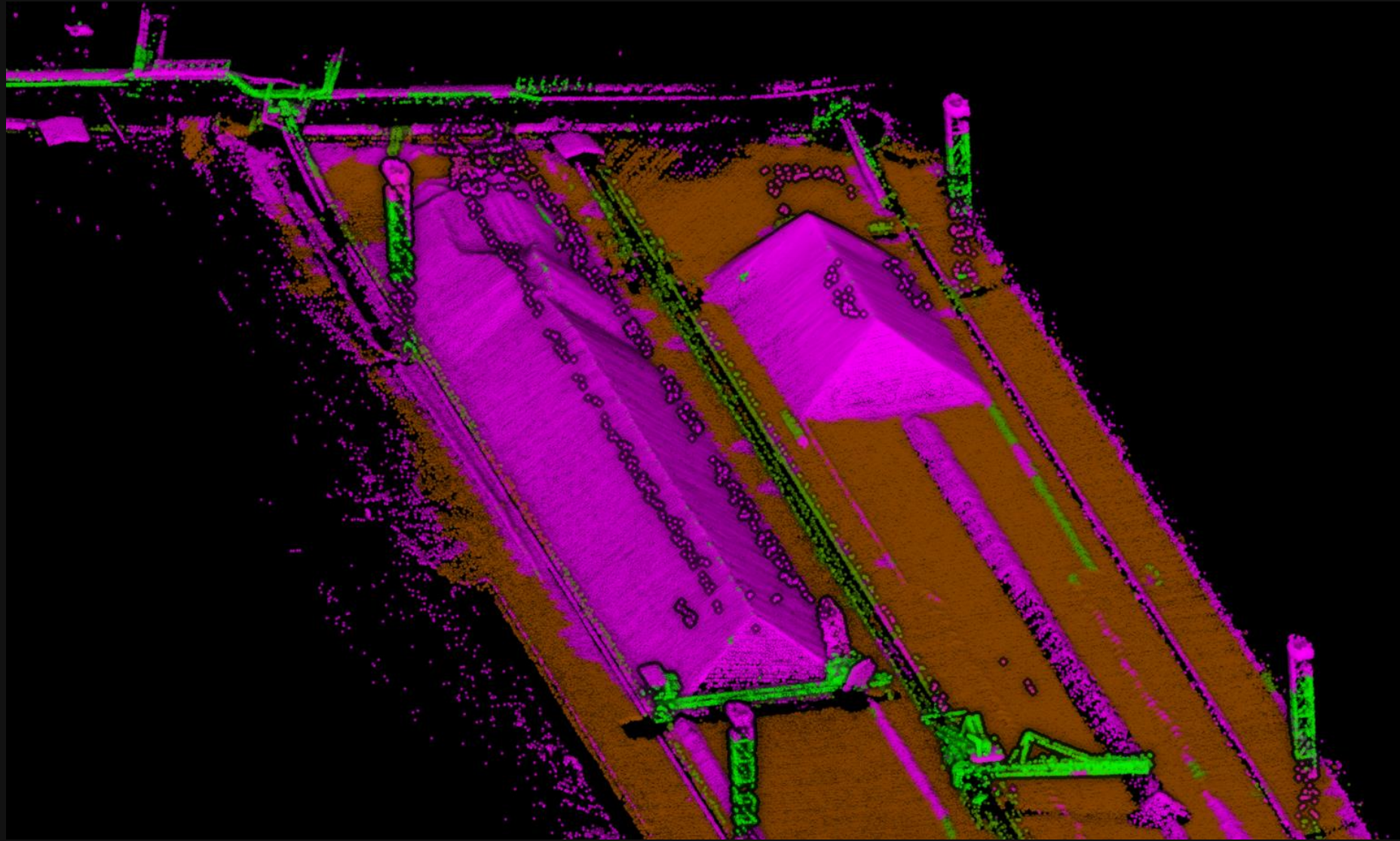


# Disaster Management and Insurance Asset Management



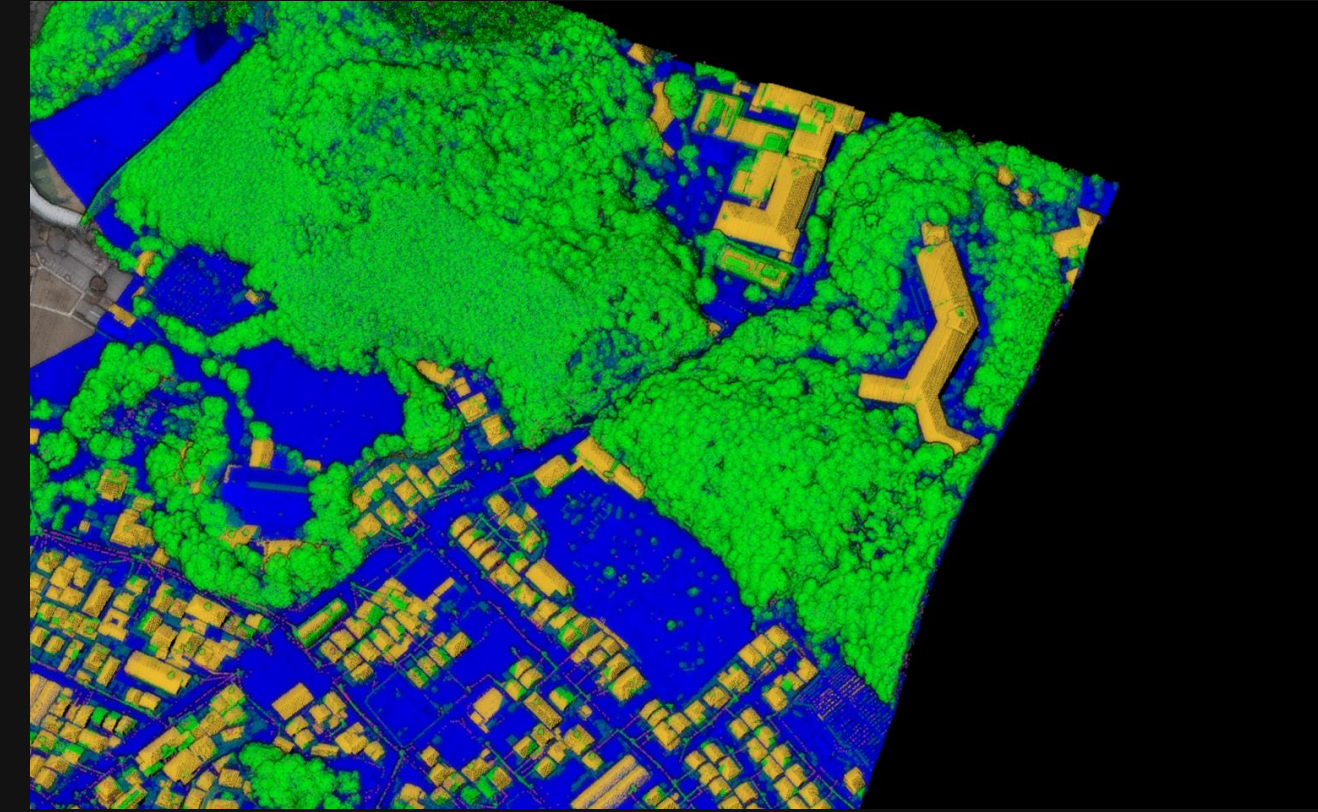
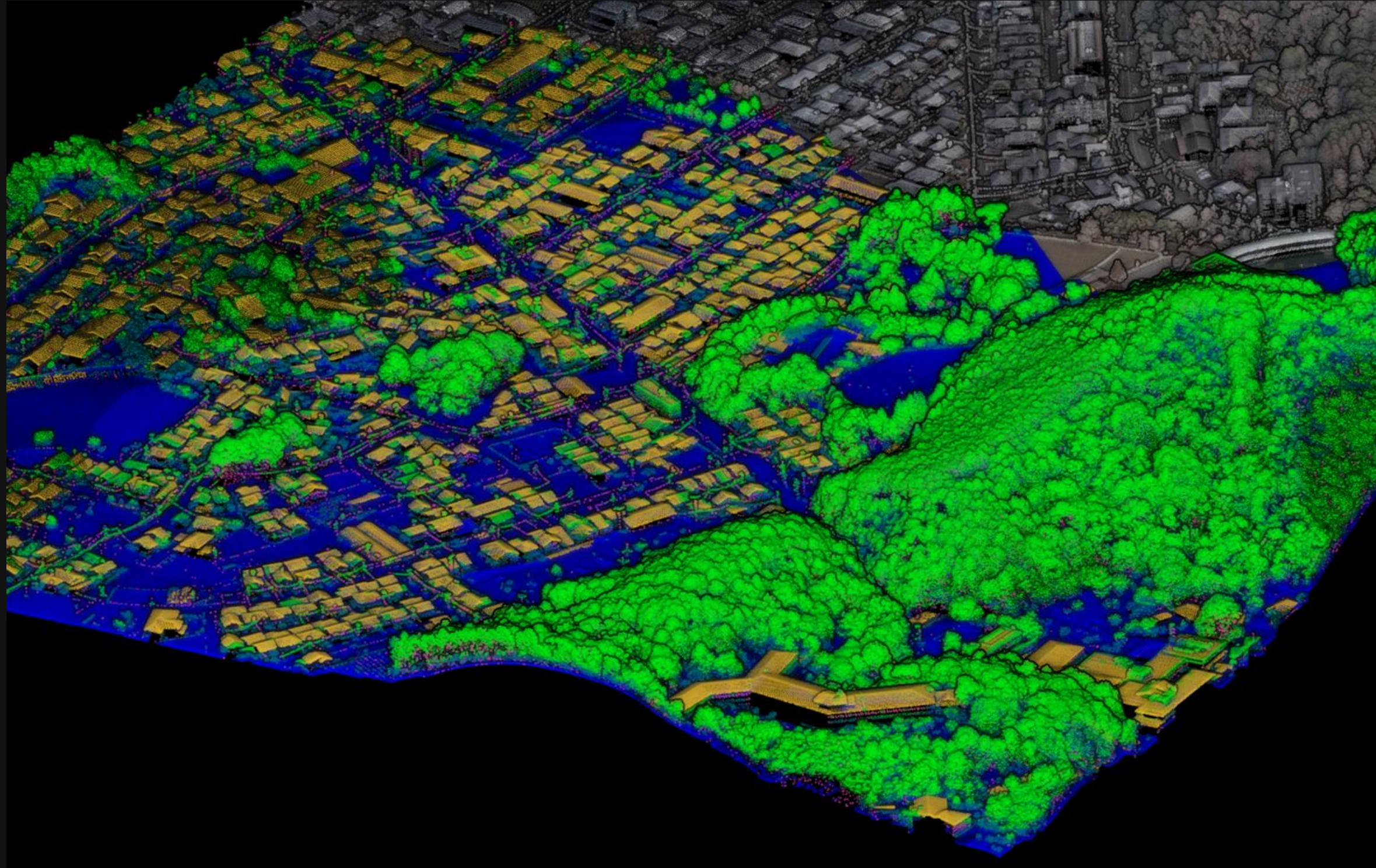


# Mining and Earth Moving Stockpile Management



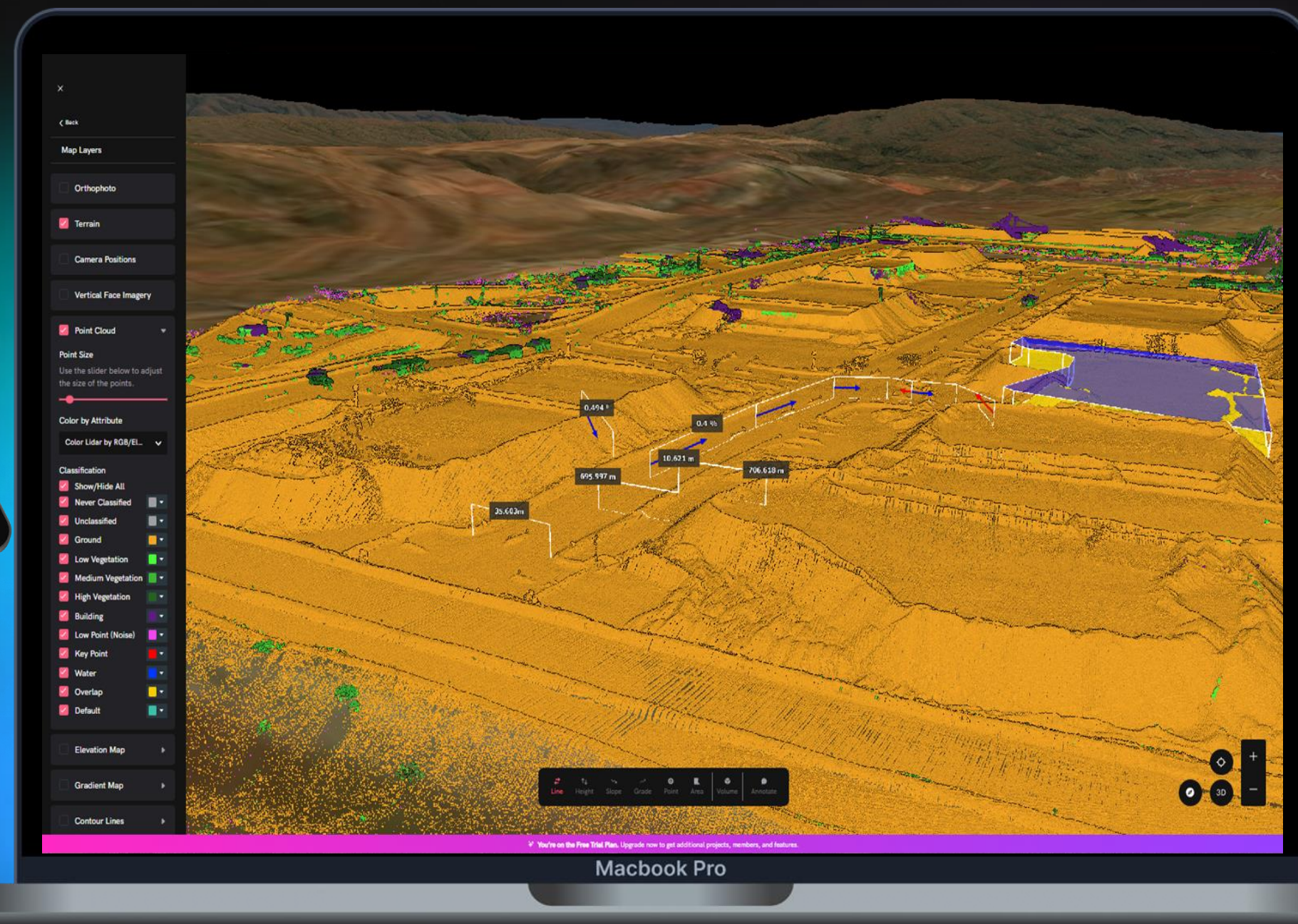


# Urban Planning & Flooding Management





# Combining GIS and Ai ML: Unlock new insights and opportunities for better decisions





Thank you!

