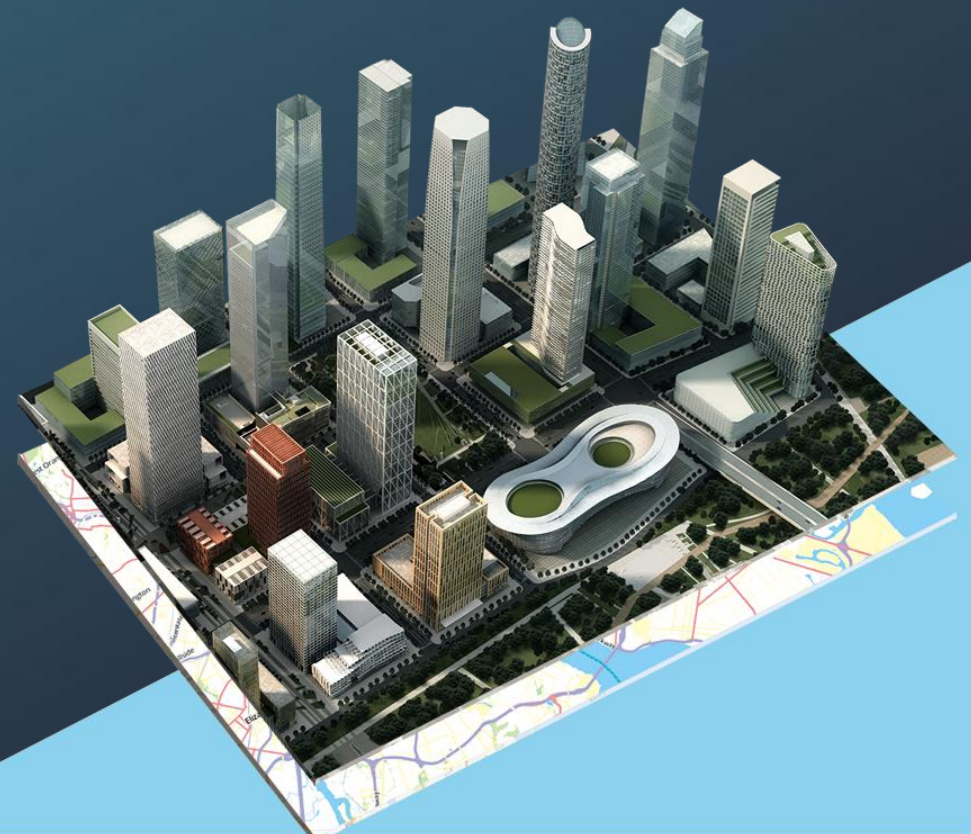
FOSS4G
#Code the #Earth, KOREA 2025
#Share the #Future

Digital Twin Platform mago3D

Gaia3D The GeoSpatial Company

State of mago3DTiler & mago3DTerrainer



2025. 12. 05.

Sanghee Shin(shshin@gaia3d.com)
Jinho Kim, Sungdo Son, Hakjoon Kim
Gaia3D, Inc.

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Gaia3D
The GeoSpatial Company

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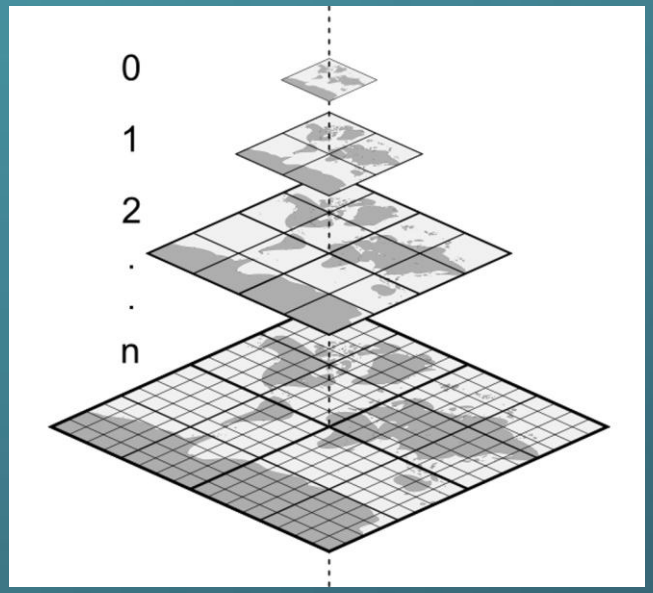

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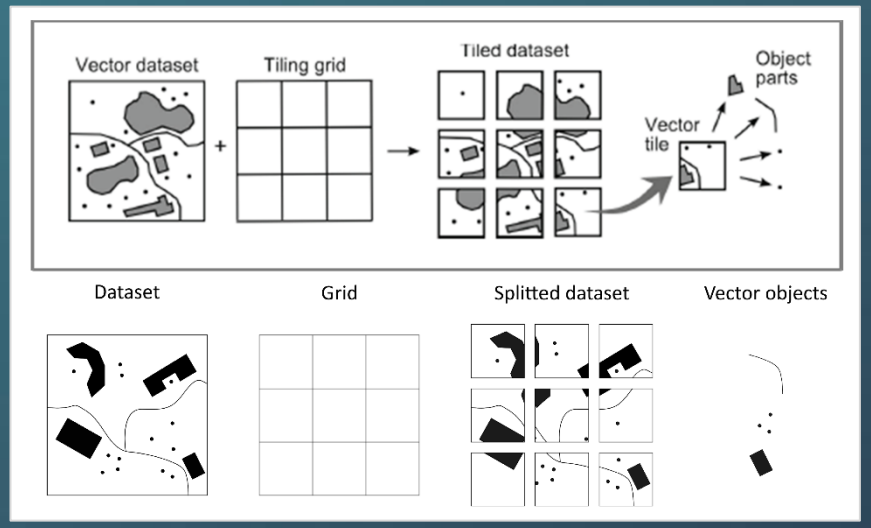

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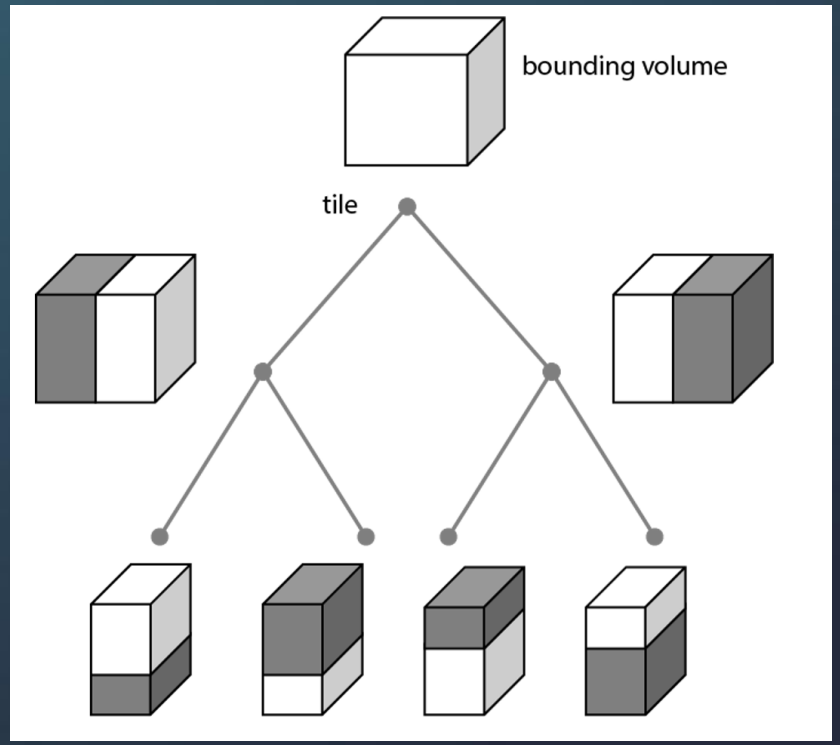


〈3D Tiles〉

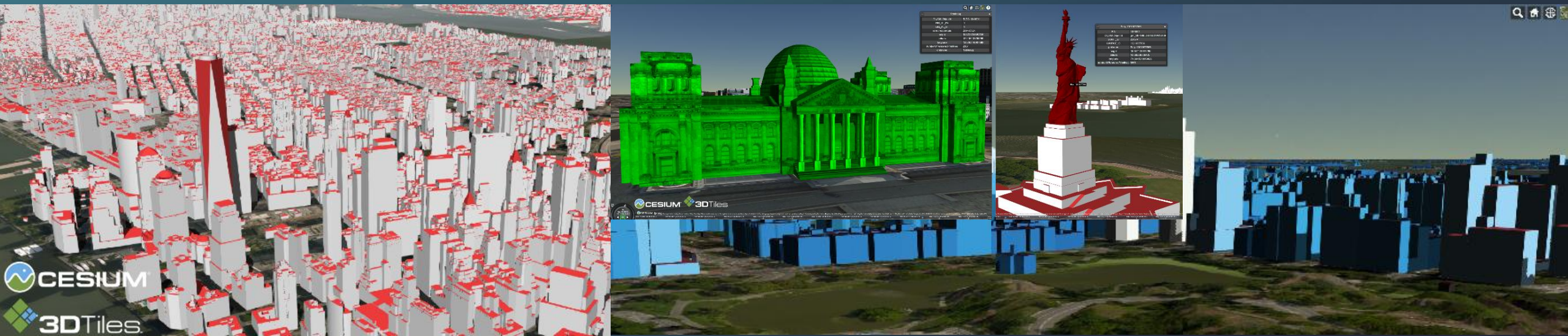
1. Before We Begin – 3D Tiles

3D Tiles – OGC Community Standard

3D Tiles Specification
Open Geospatial Consortium

- Designed for streaming and rendering massive 3D geospatial content (3D Model, Points Cloud, Reality Mesh, etc.)

- Hierarchical data structure and a set of tile formats which deliver renderable contents



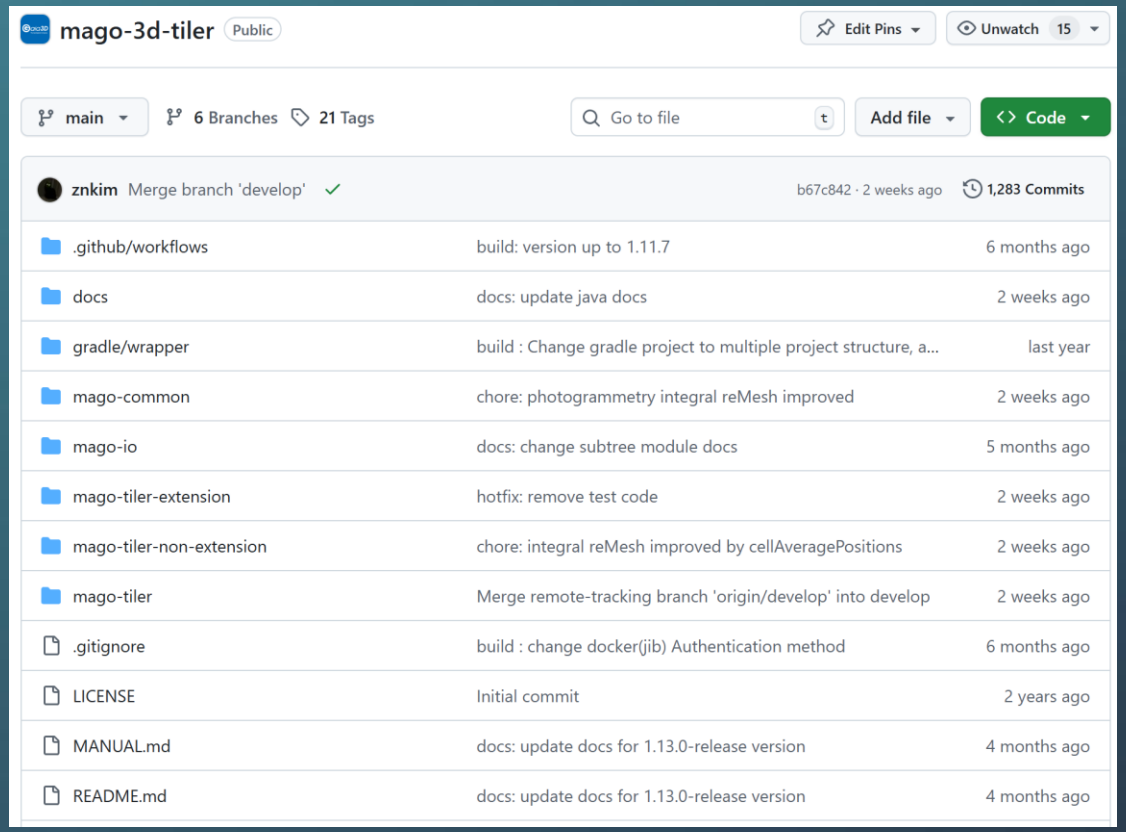
Originally Supported Features

mago3DTiler

mago 3DTiler https://github.com/Gaia3D/mago-3d-tiler

: Java based open source OGC 3D Tiles maker developed by Gaia3D

https://github.com/Gaia3D/mago-3d-tiler



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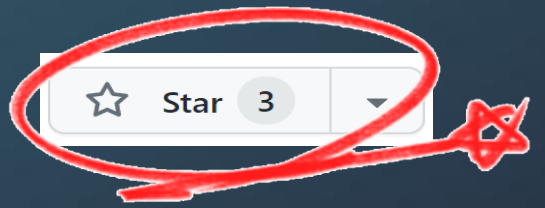

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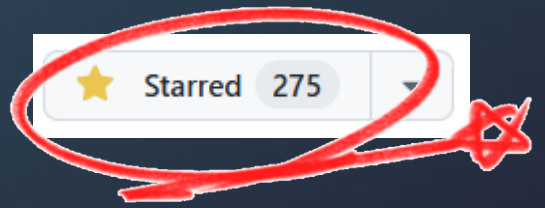


Latest Version: 1.14

mago3DTiler

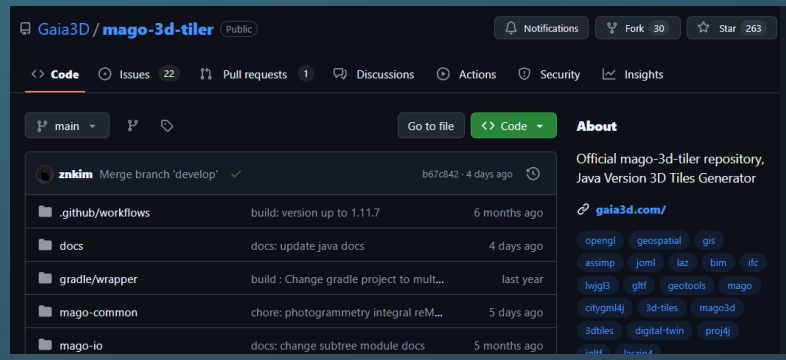
mago 3DTiler

https://github.com/Gaia3D/mago-3d-tiler

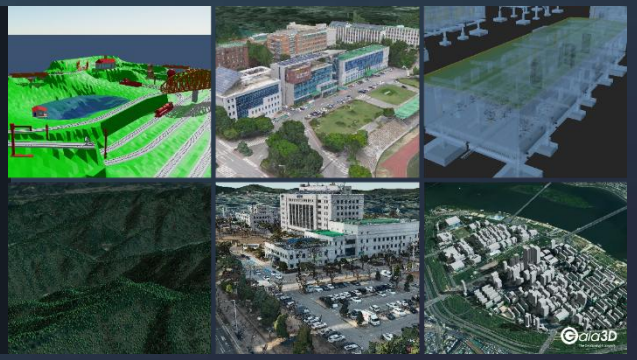
: Java based open source OGC 3D Tiles maker developed by Gaia3D

3D Tiles Specification — Open Geospatial Consortium

Open Source	**No dependencies** on any specific company or technology
Portable & Scalable	Offering excellent **interoperability, portability, and scalability** with other systems
SRS Conversion	**Real-time SRS transformation** during 3D Tiles making
Fast Speed	Fast 3D Tiles making with parallel processing and fast rendering with data optimization
Model Extrusion Support	**Extruded 3D Tiles making** from 2D SHP, GeoJSON using attribute
Various Formats Support	3DS, OBJ, FBX, IFC, CityGML, IndoorGML, LAS, LAZ, SHP, GPKG, and others
Enhanced Debugging	Easy debugging through detailed exception handling and logging features




```
----------------------------------------
mago-3d-tiler(dev) by Gaia3D, Inc.
----------------------------------------
Usage: command options
 -h, --help                Print Help
 -q, --quiet               Quiet mode/Silent mode
 -lt, --leaveTemp          Leave temporary files
 -m, --merge               Merge tileset.json files
 -i, --input <arg>         Input directory path
 -o, --output <arg>        Output directory file path
 -it, --inputType <arg>    Input files type [kml, 3ds, fbx, obj,
 -ot, --outputType <arg>   Output 3DTiles Type [b3dm, i3dm, pnts
 -l, --log <arg>           Output log file path.
 -r, --recursive           Tree directory deep navigation.
```



mago3DTiler

Support for Various Formats

- 3DS, OBJ, COLLADA, IFC, FBX, PLY, Point Cloud(LAS, LAZ)
- All formats supported by ASSIMP (Open Asset Import Library, BSD3) can be theorectically supported.
- Polygon geometry + Height property described in SHP or GeoJSON formats is also supported.

Support for Various Coordinate Systems

- Supports all coordinate systems provided by PROJ

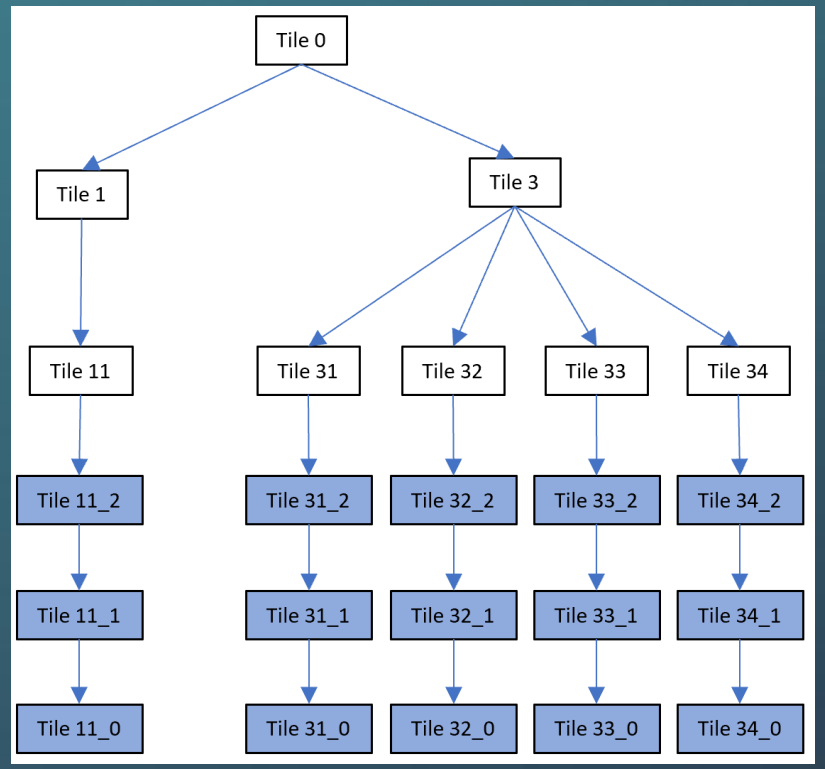
mago3DTiler

3D Tiles Specification — Open Geospatial Consortium

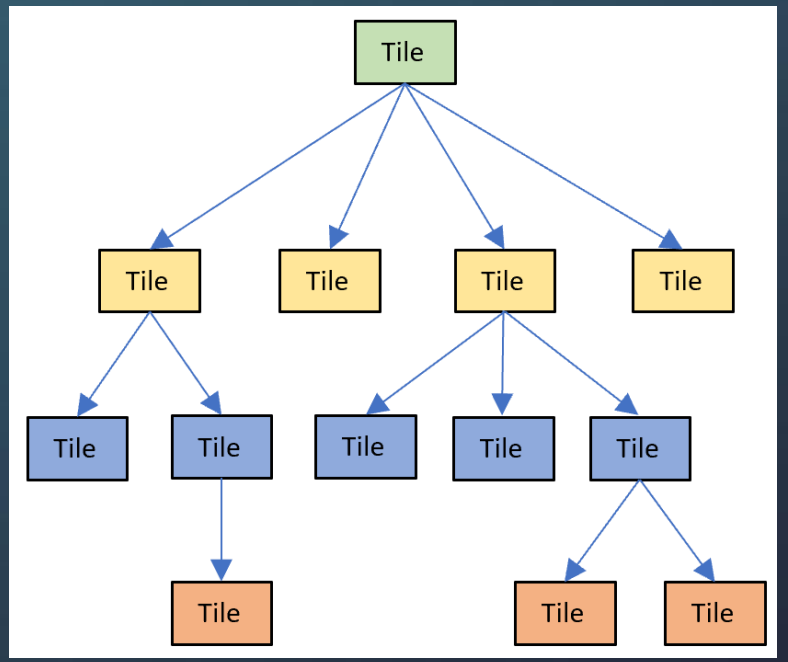
mago 3D Tiler https://github.com/Gaia3D/mago-3d-tiler

: Java based open source OGC 3D Tiles maker developed by Gaia3D

» ① Generate 3D Tiles with a more parent-child structure



<3D Tiles generated by other software>



<3D Tiles generated by mago3DTiler>

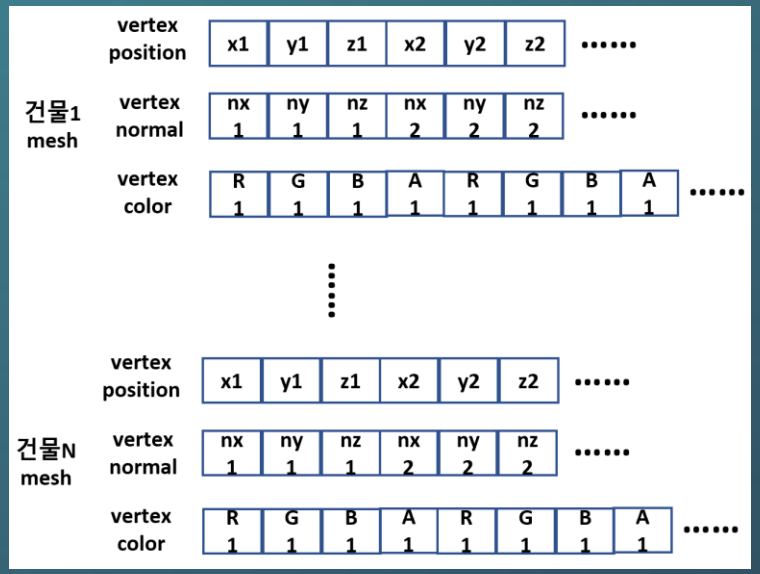
mago3DTiler

3D Tiles Specification — Open Geospatial Consortium

mago 3D Tiler https://github.com/Gaia3D/mago-3d-tiler

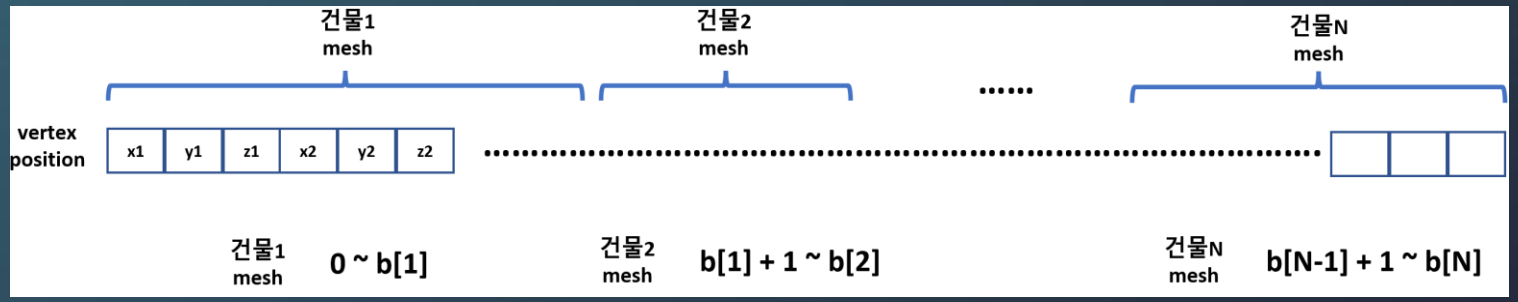
: Java based open source OGC 3D Tiles maker developed by Gaia3D

» ② Batching optimization



<3D Tiles generated by other software>

Array Buffer Optimization



<3D Tiles generated by mago3DTiler>

mago3DTiler

3D Tiles Specification

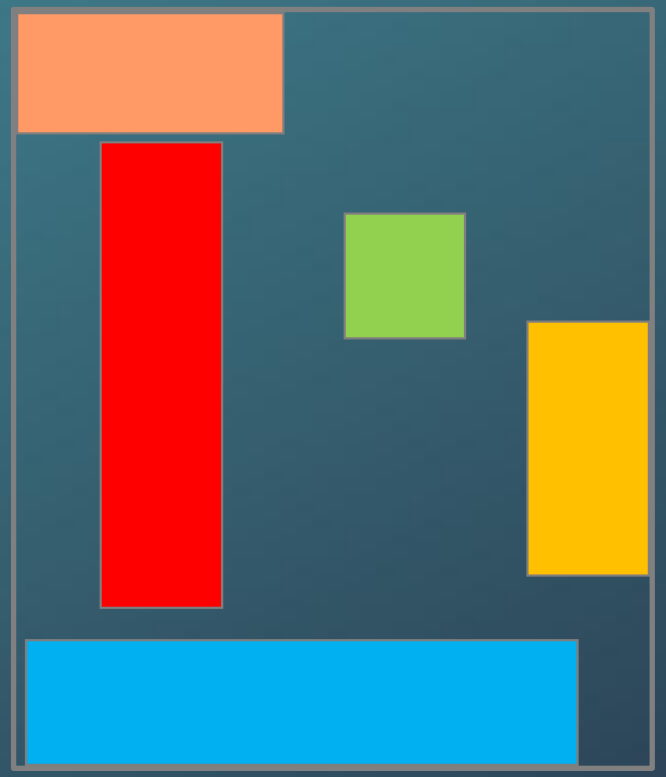
Open Geospatial Consortium

mago 3D Tiler https://github.com/Gaia3D/mago-3d-tiler

: Java based open source OGC 3D Tiles maker developed by Gaia3D

» ③ Texture Size Optimization

N Textures



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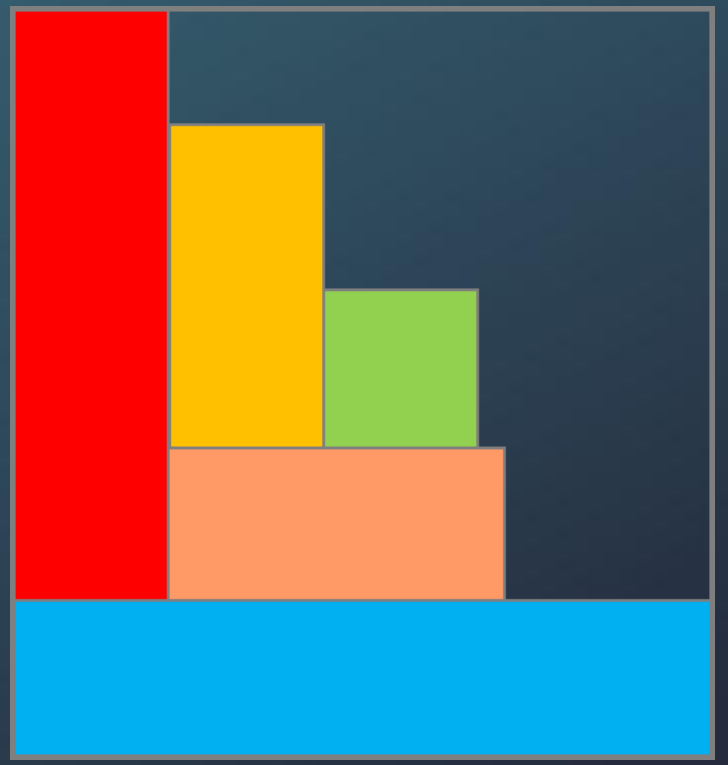
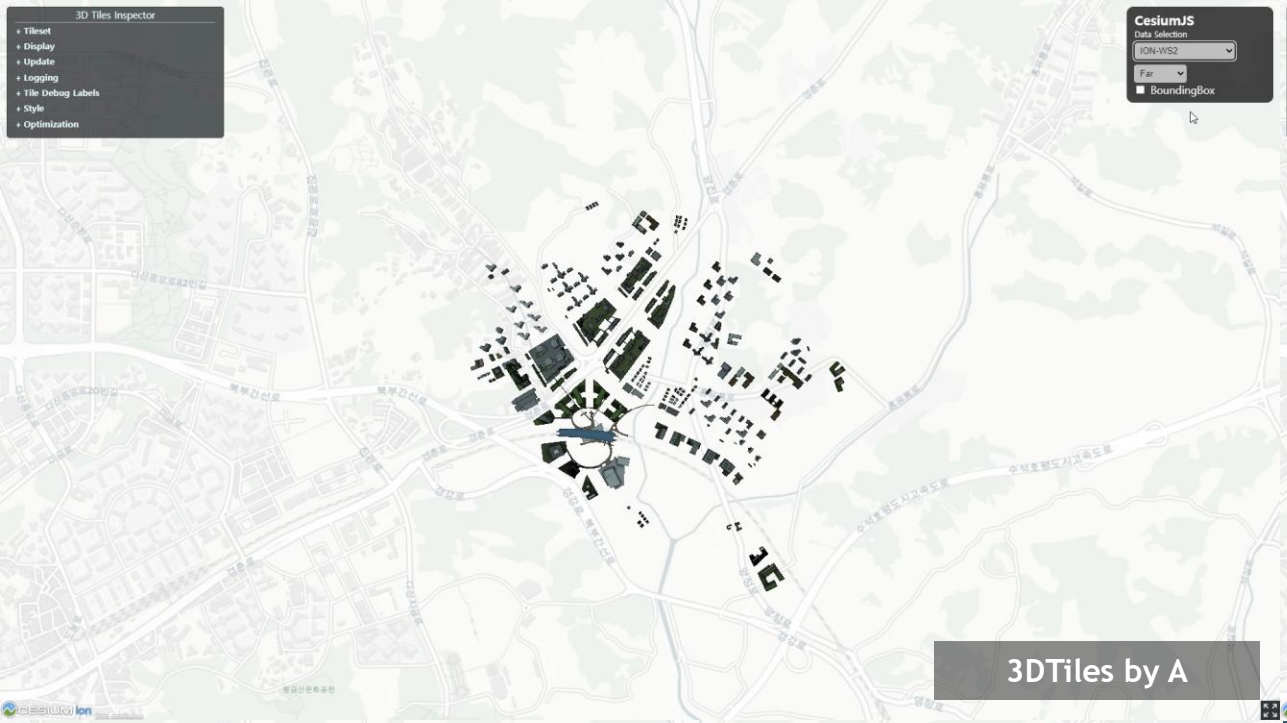


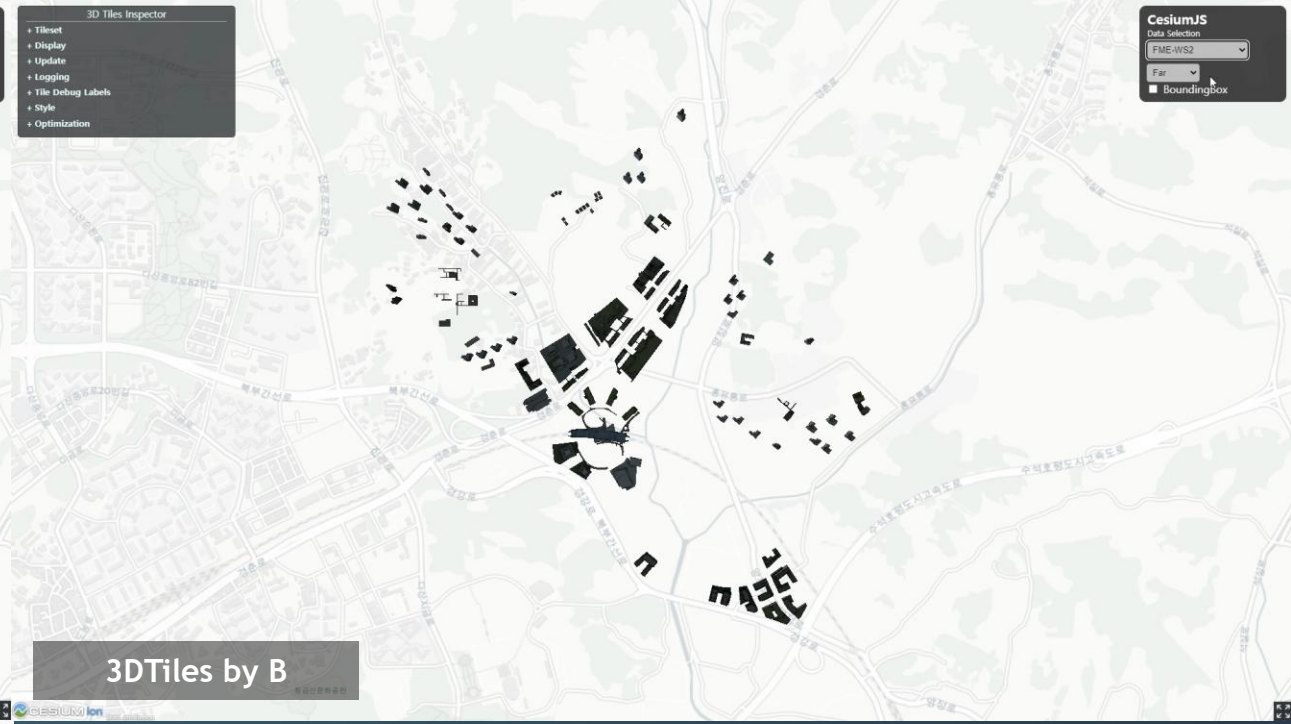
1 Texture

<3D Tiles generated by mago3DTiler>

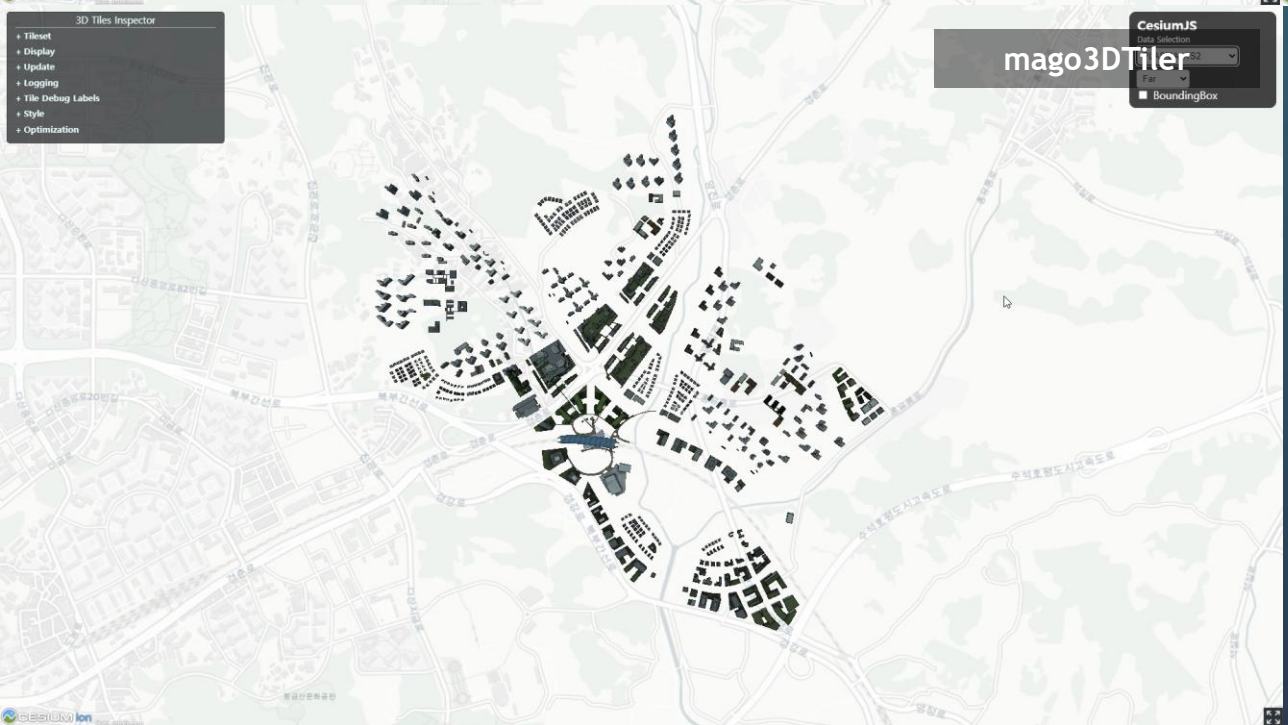
Gaia3D The GeoSpatial Company



3DTiles by A



3DTiles by B

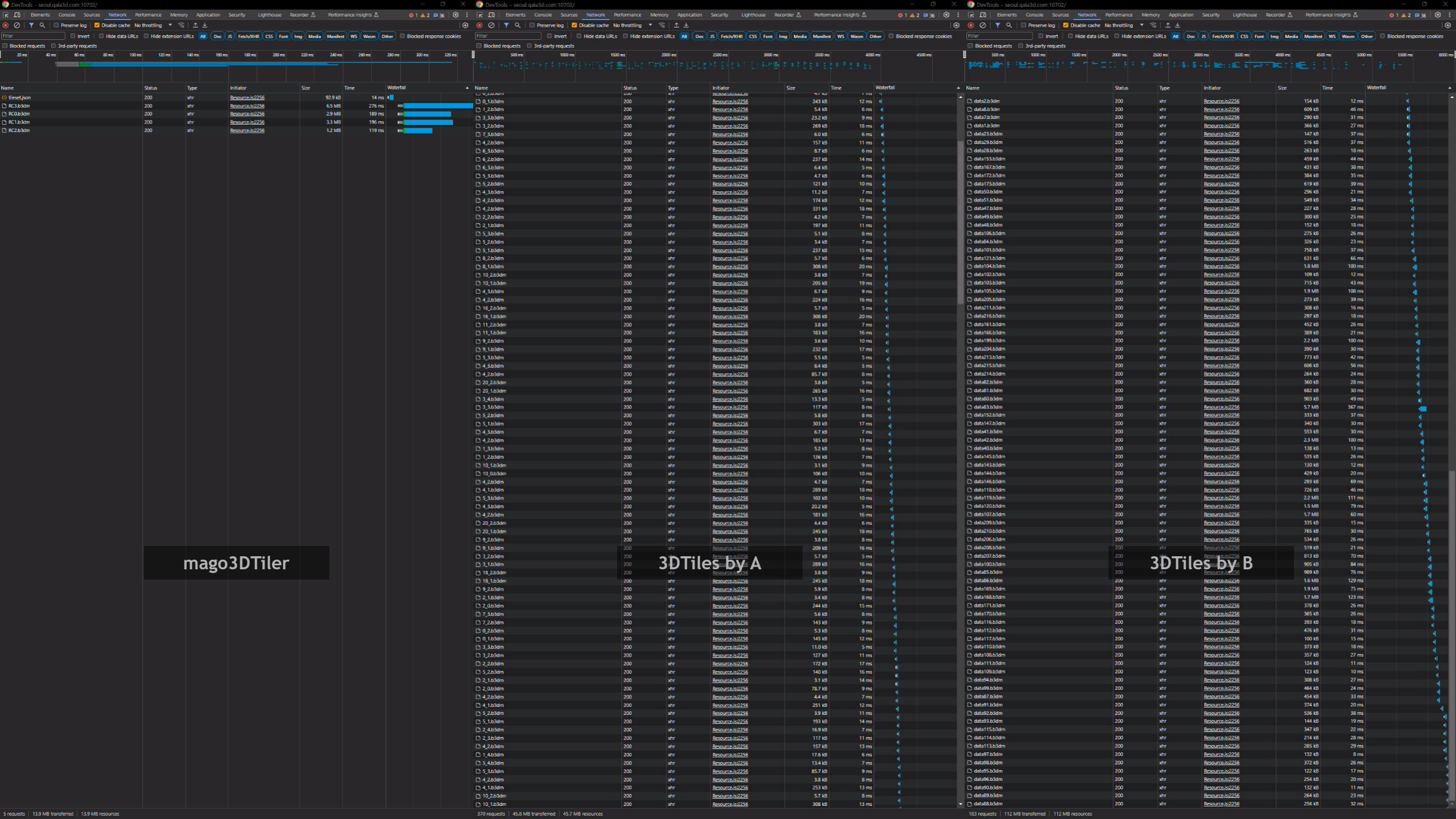


mago3DTiler

mago 3D Tiler

Data loading & rendering speed test using Cesium.js

Gaia3D
The GeoSpatial Company

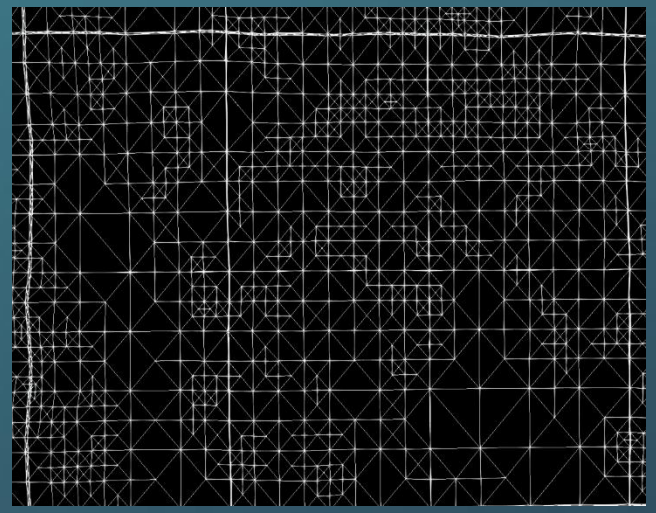

mago3DTiler
3DTiles by A
3DTiles by B

mago3DTerrainer

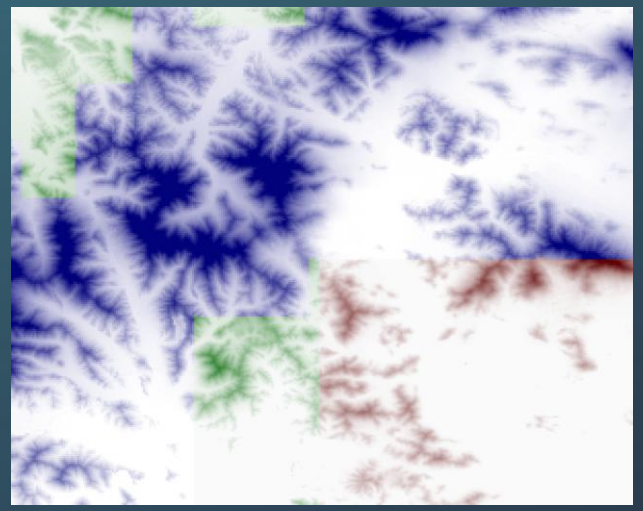
From Urban to Terrain — mago3DTerrainer

mago3DTiler focuses on urban and object-based 3D data, so mago3DTerrainer complements it for terrain data processing

- Simple to use, fast DEM-to-Terrain conversion
- Supports multiple GeoTIFF inputs and multi-CRS handling via Proj
- Prioritizes high-resolution data when mixing multiple datasets
- RTIN-based terrain generation



<Wireframe Terrain>



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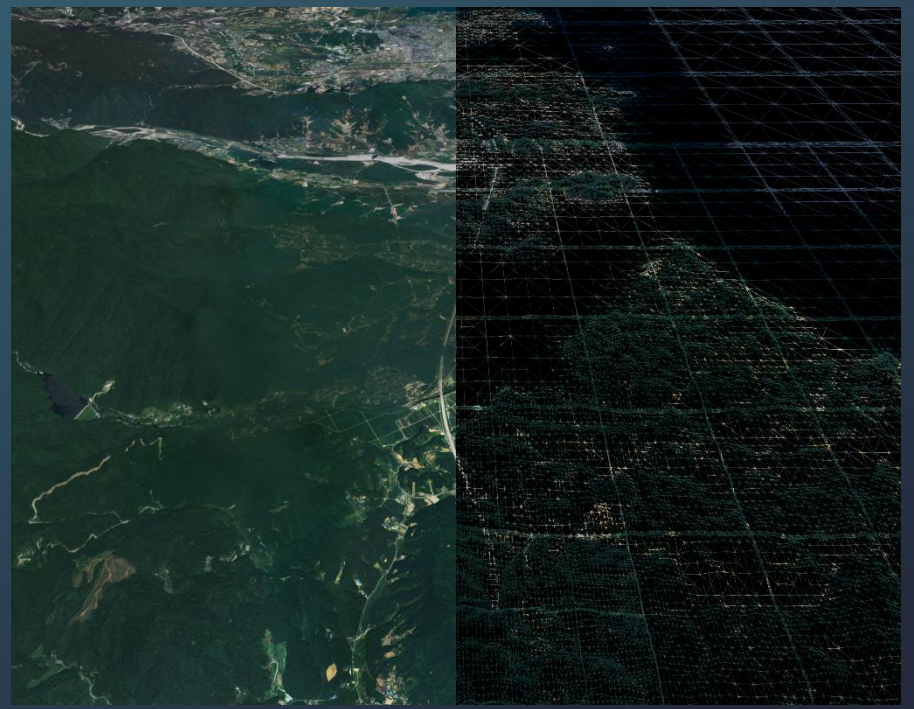


<Terrain Wireframe Comparing Screenshot>

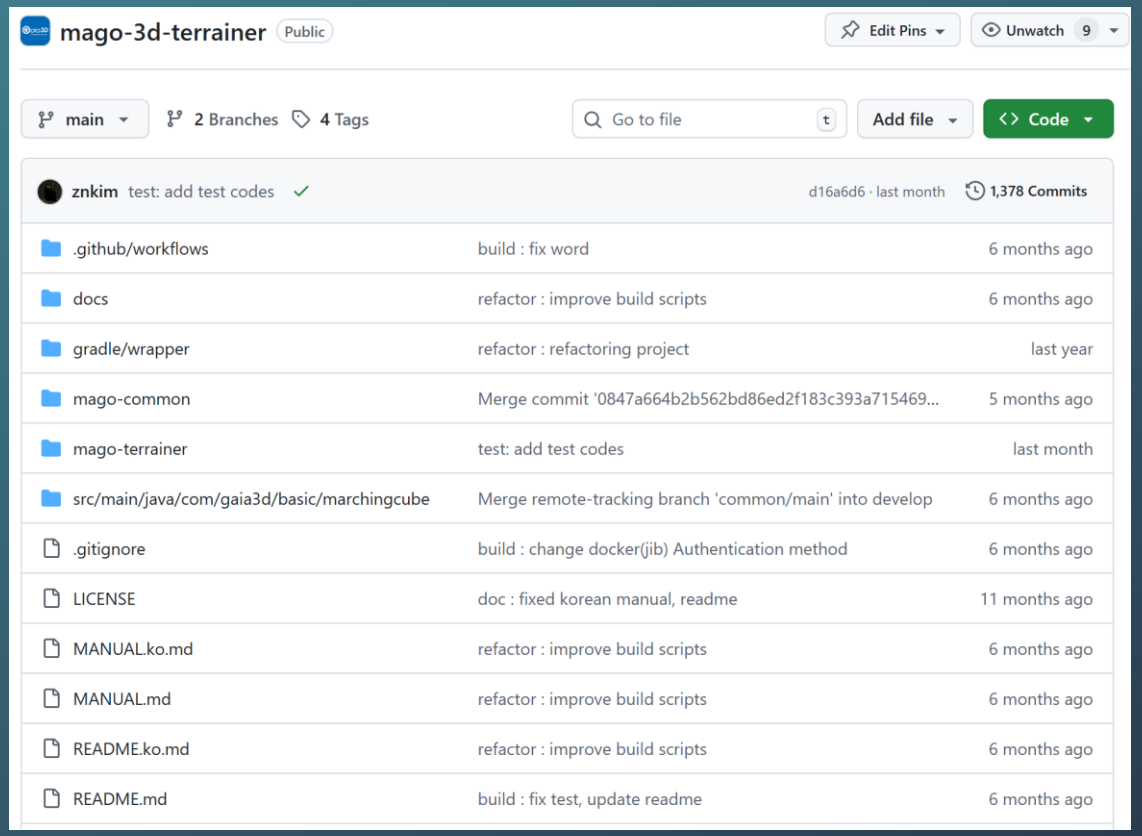
mago3DTerrainer

mago 3DTerrainer

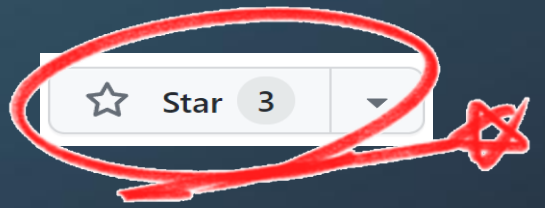
https://github.com/Gaia3D/mago-3d-terrainer

: Java based open source quantized-mesh terrain generator

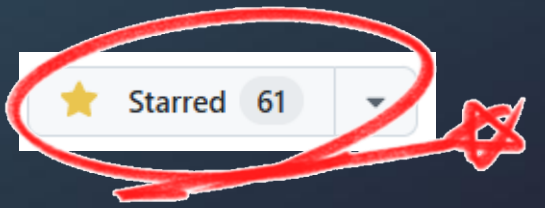
https://github.com/Gaia3D/mago-3d-terrainer



〈May 2025〉



〈December 2025〉



Latest Version: 1.10

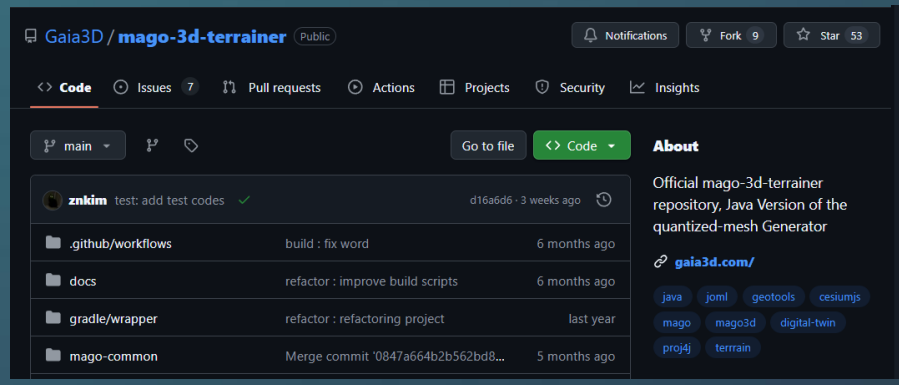
mago3DTerrainer

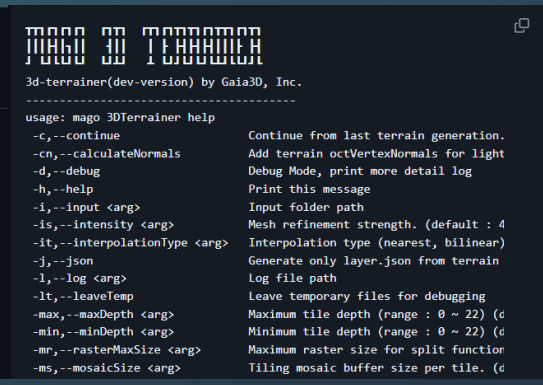
mago 3DTerrainer

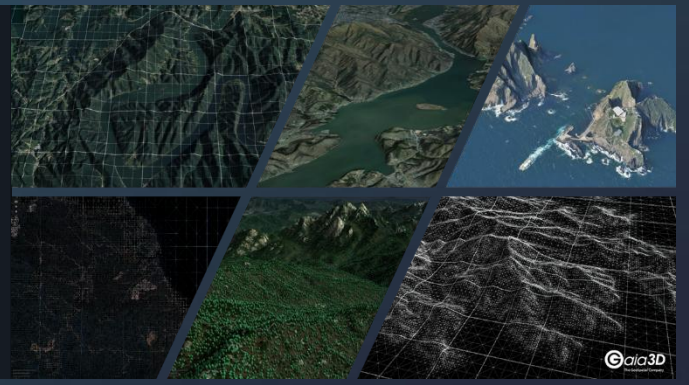
https://github.com/Gaia3D/mago-3d-terrainer
https://github.com/CesiumGS/quantized-mesh

: Java based open source quantized-mesh terrain generator

Open Source	**No dependencies** on any specific company or technology
Portable & Scalable	Offering excellent **interoperability, portability, and scalability** with other systems
SRS Conversion	**Real-time SRS transformation** during 3D Tiles making
High accuracy	Generate quantized-mesh data with high accuracy.
Multiple data conversion	Convert **multiple GeoTIFF** data at once.
Customizable options	**Provides various customization options** such as min/max tile depth, tile raster max size, tile mosaic size, tile generation strength, interpolation method, etc.



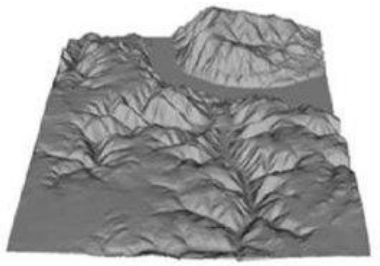




Why we use RTIN(Right-Triangulated Irregular Network Type)?

We adopted the **RTIN**-based method as our primary terrain generation approach.

- RTIN provides an efficient balance between TIN and traditional terrain grids
- It captures terrain features accurately while keeping the mesh lightweight
- The refinement process allows flexible control over detail levels
- Because refinement can be adjusted, LOD generation becomes much easier and more efficient



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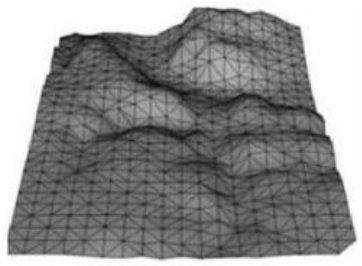
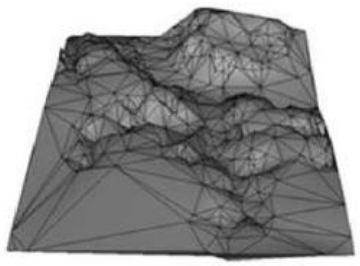


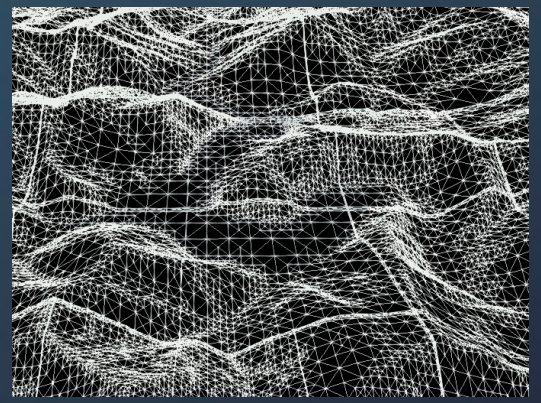
TRN
<Triangulated Regular Networks>



TIN
<Triangulated Irregular Networks>

image source:
https://www.researchgate.net/publication/278133551_Developing_an_opensource_software_system_for_the_digital_terrain_model_based_on_TIN

<Terrain Mesh Types>



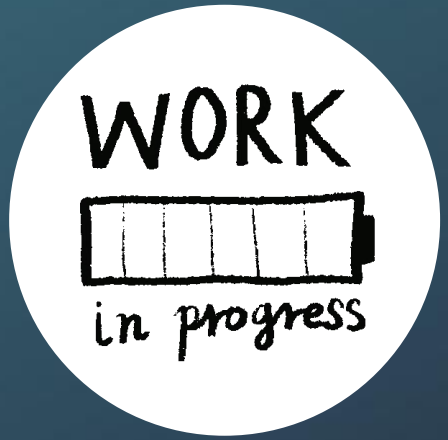
RTIN
<Right-Triangulated Irregular Network Type>

2. Originally Supported Features

License

- mago3DTiler, mago3DTerrainr are released under the MPL 2.0 license (https://www.mozilla.org/en-US/MPL/2.0/)
- If you do not wish to disclose the modified code under the MPL 2.0 license, you may opt for a commercial license. In this case, please contact us at sales@gaia3d.com

"It's a work in progress



Good things take time!"

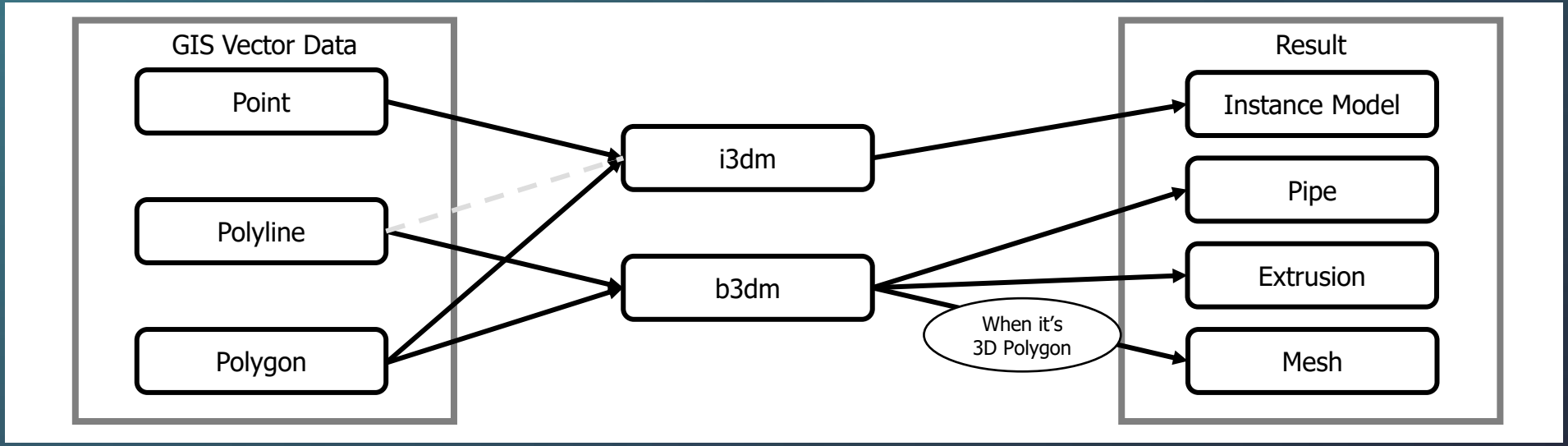
Newly Supported Features

(mago3DTiler)

3D Tiles Making from 2D Map

More flexible 2D map conversion features

- Enhanced 2D map data conversion for more flexible use, including extrusion and underground pipe generation features.
- It's not just about converting point-type data to i3dm—it also enables generating random instances within polygons.

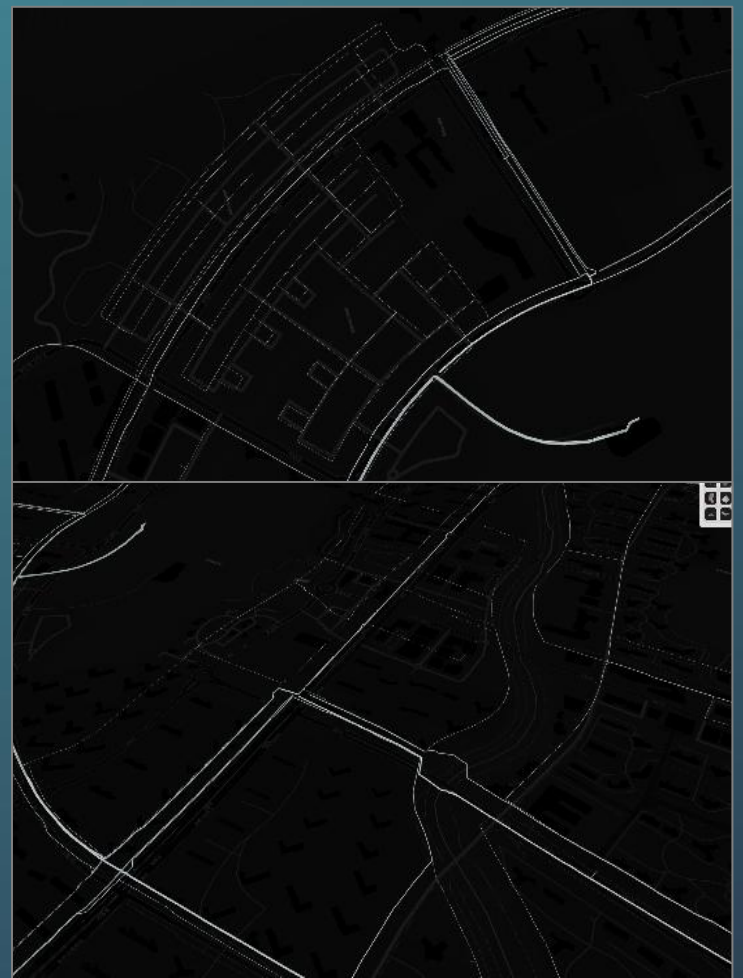


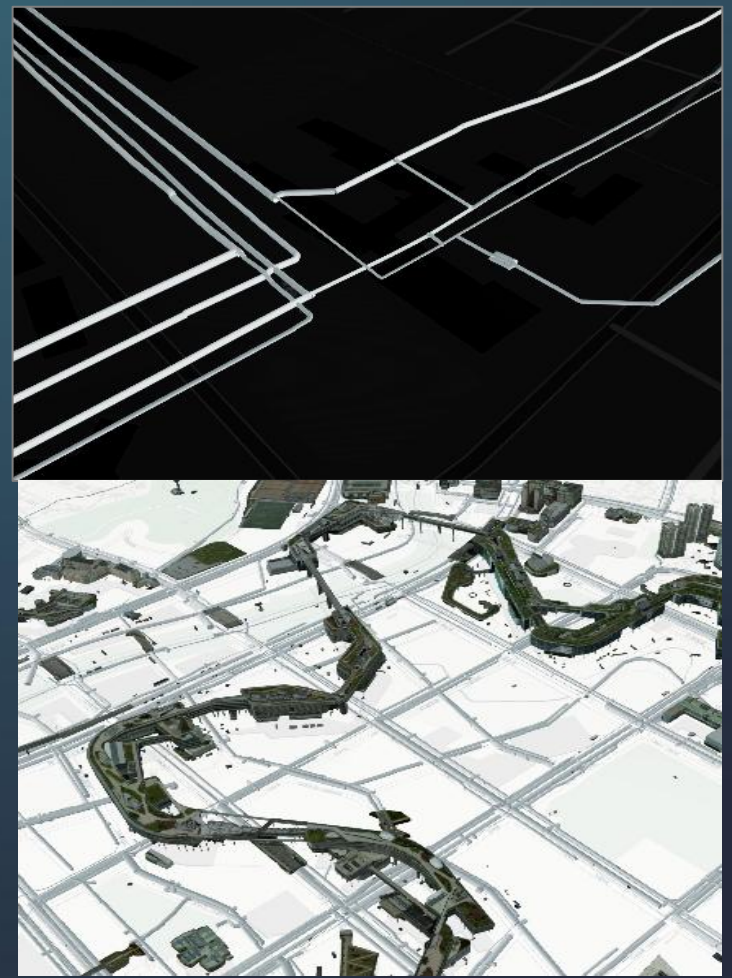
<3D Tiles Conversion Flow from 2D Map>

3D Tiles Making from 2D Map

Underground Facility Support

- Use underground drawings or maps in SHP format (linestring)
- Use specific attributes as diameter and node depth





3D Tiles Making from 2D Map

Multi-LOD I3DM Support

- I3DM that allows for easy reuse of the same model, like a cookie-cutter molds
- If the model has a large file size, create LOD-specific cookie-cutter molds from the original model

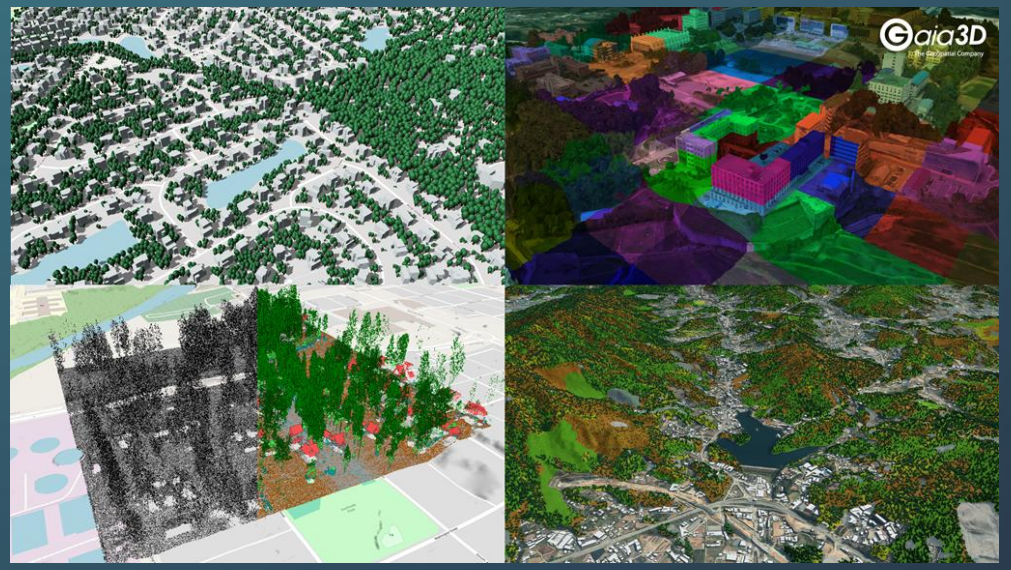
Street tree I3DM using large-scale tree models

LOD processing of the original instance

3DTiles 1.1

Supporting OGC 3DTiles Version 1.1

https://docs.ogc.org/cs/22-025r4/22-025r4.html



Support for 3D Tiles 1.1 Specification

- The default tileset version is now `1.1`.
- You can still generate tiles in the `1.0` format by using the option:

```
--tilesVersion 1.0
```

- Legacy tile formats (`b3dm` , `i3dm` , `pnts`) have been replaced with glTF (`.glb`) based structures.
- Extension handling has been updated to use both Tileset and glTF extensions as specified in the 1.1 standard.

3D Tiles Making from 2D Map

Applying Remeshing Techniques to LOD

- ✓ We generated South Korea's forest i3dm data using a Forest-Type based on polygons.
- ✓ We created realistic forest data by using forest **density**, **tree species**, **tree height**, and random heading.

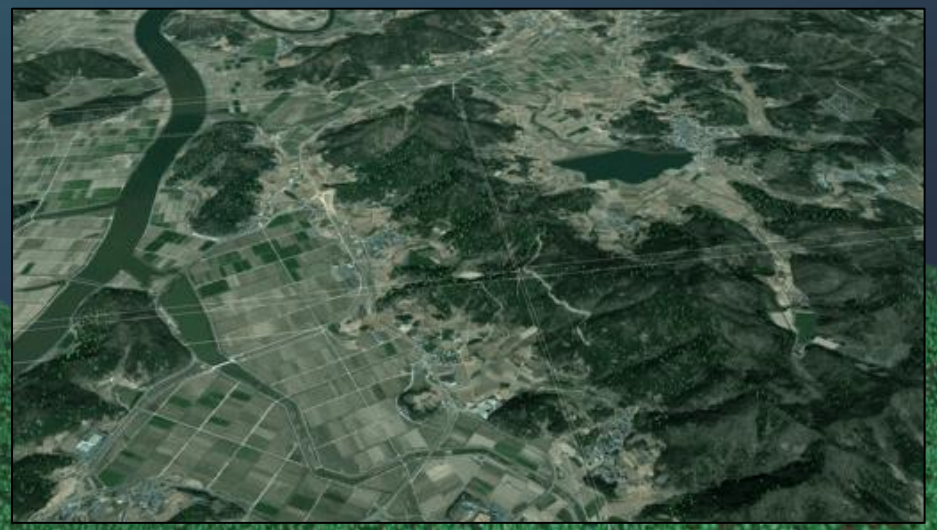
You can now create i3dm using Polygon.

--densityColumn <arg> : Polygon instance generation density relative to area

--scaleColumn <arg> : Instance size

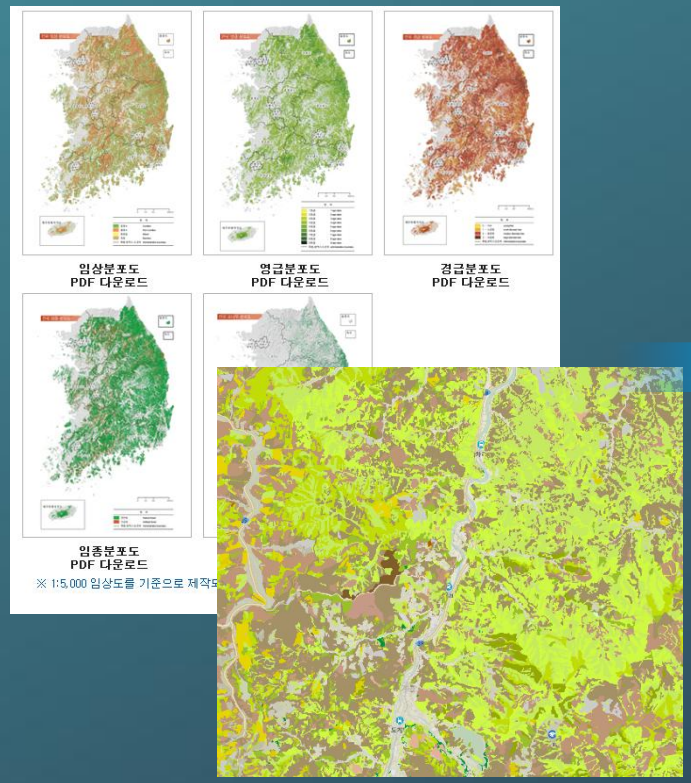
--AttributeFilter <arg> : Feature attribute filter

--headingColumn <arg> : Instance heading

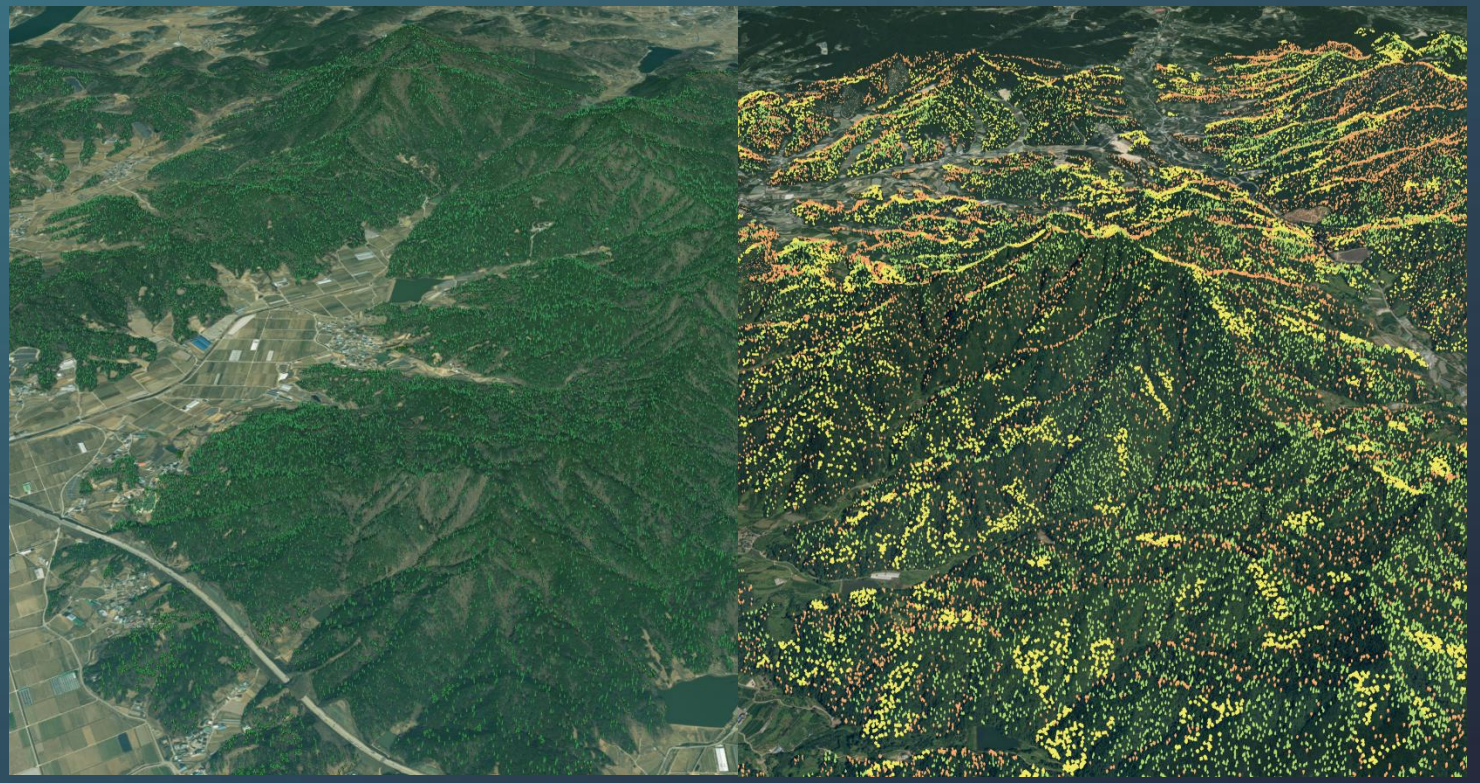


3D Tiles Making from 2D Map

Building a Forest with the i3dm Format



<Forest Maps from the Korea Forest Service>
2D Vector Polygon



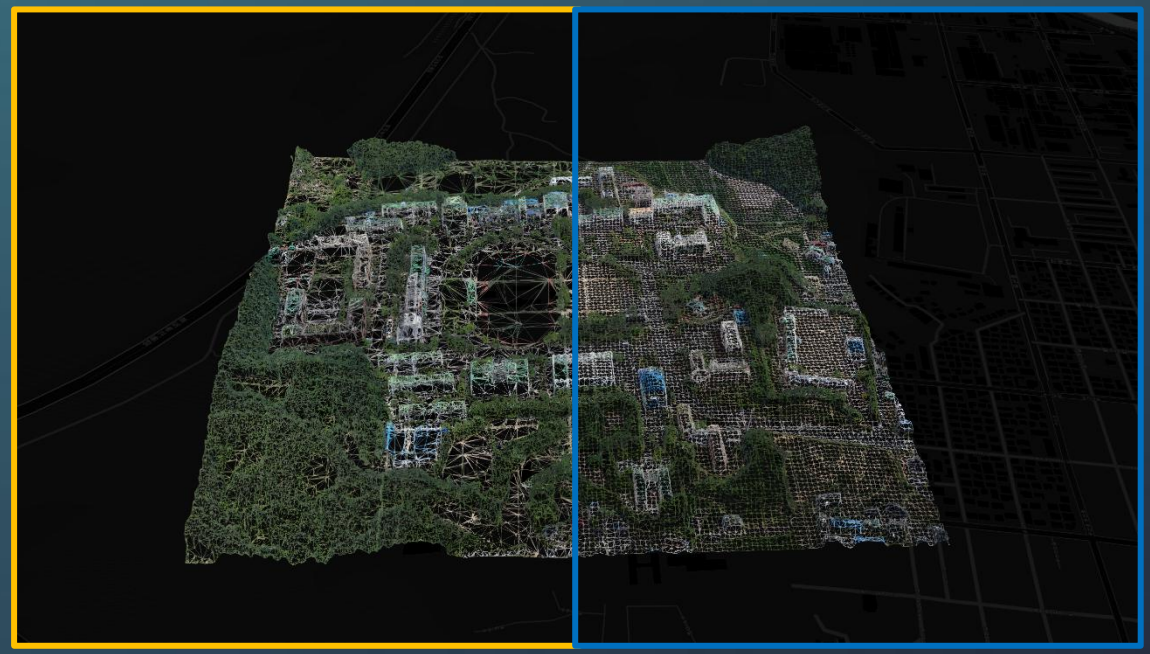
<Generated Forest 3DTiles(i3dm)>

3D Tiles Making from 2D Map

Improvement of Reality Mesh Conversion

Visual Improvement and Size Optimization

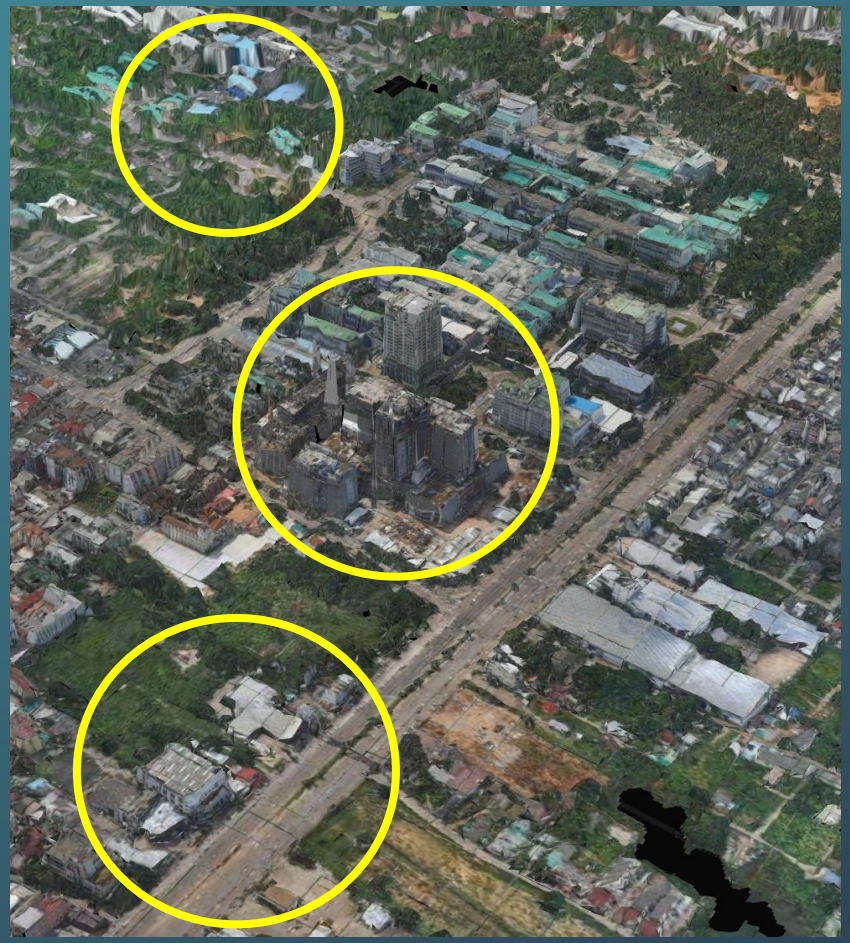
- By applying mesh optimization techniques such as **remesh** and **decimate**, along with enhanced retexturing capabilities, we **minimized the visual gap between high LOD and low LOD** while reducing file size.
- applying glTF mesh quantization.



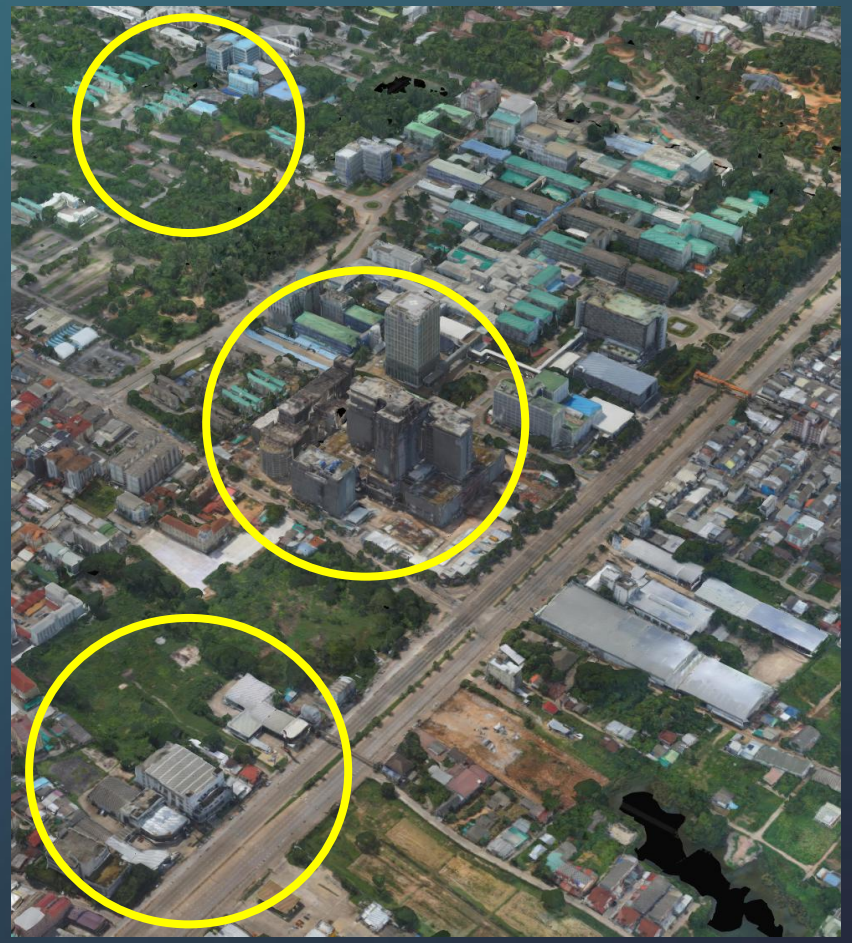
<L : Decimate, R : Remesh>

Improvement of Reality Mesh Conversion

Visual Improvement and Size Optimization



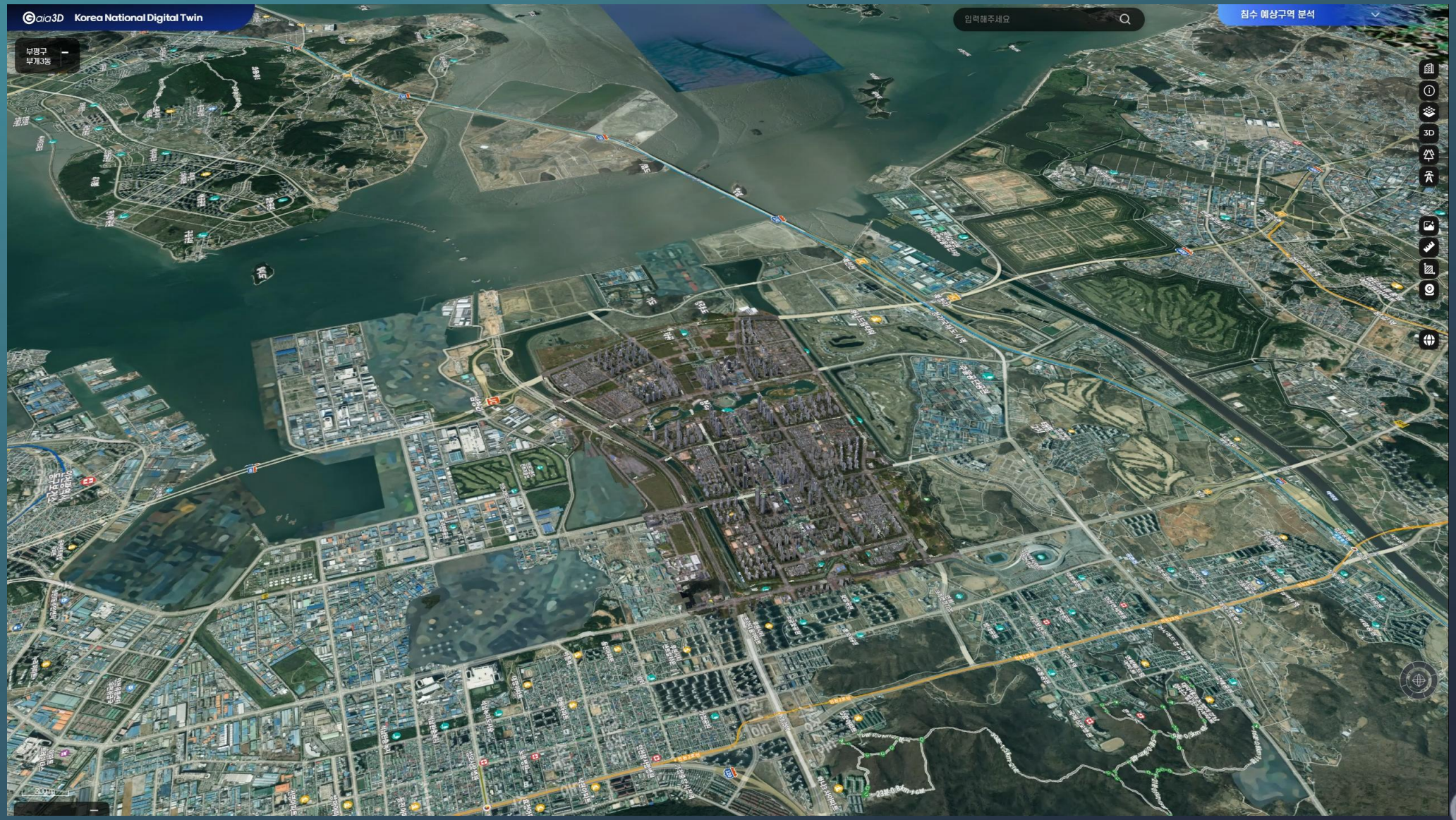
<Old Version>



<New Version>

3. Newly Supported Features (mago3DTiler)

Improvement of Reality Mesh Conversion

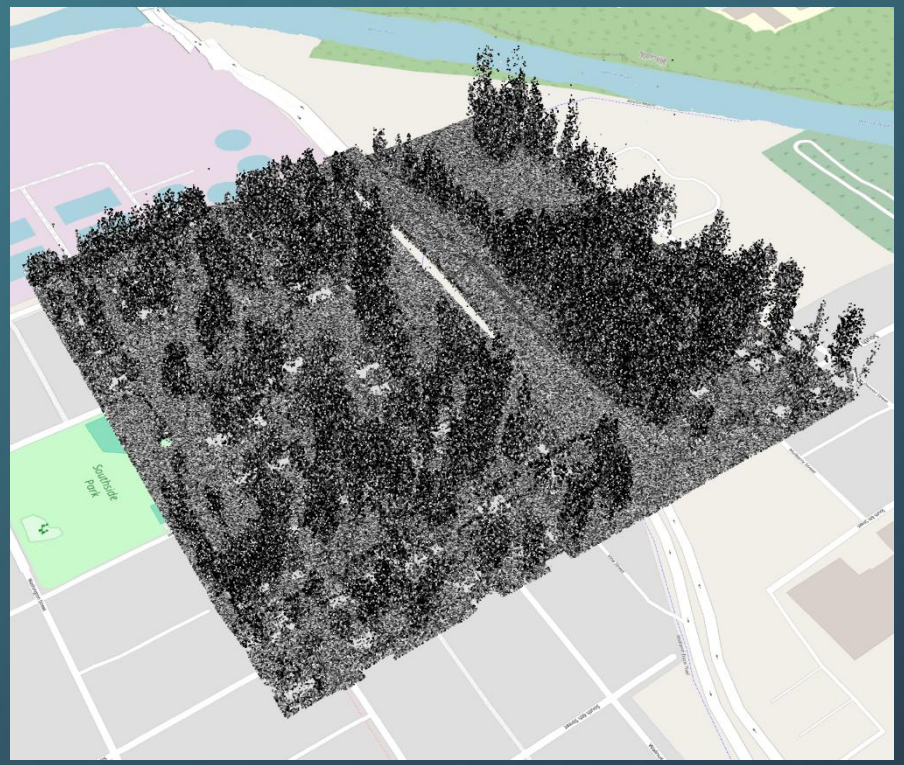


Improvement of Point Cloud Conversion

Support for Intensity, Classification in point clouds

Now, not only the **RGB** data from LAS files but also attribute information such as **Intensity** and **Classification** is included in 3DTiles.

They are included in the glTF's attributes, so they can be used through a custom shader.

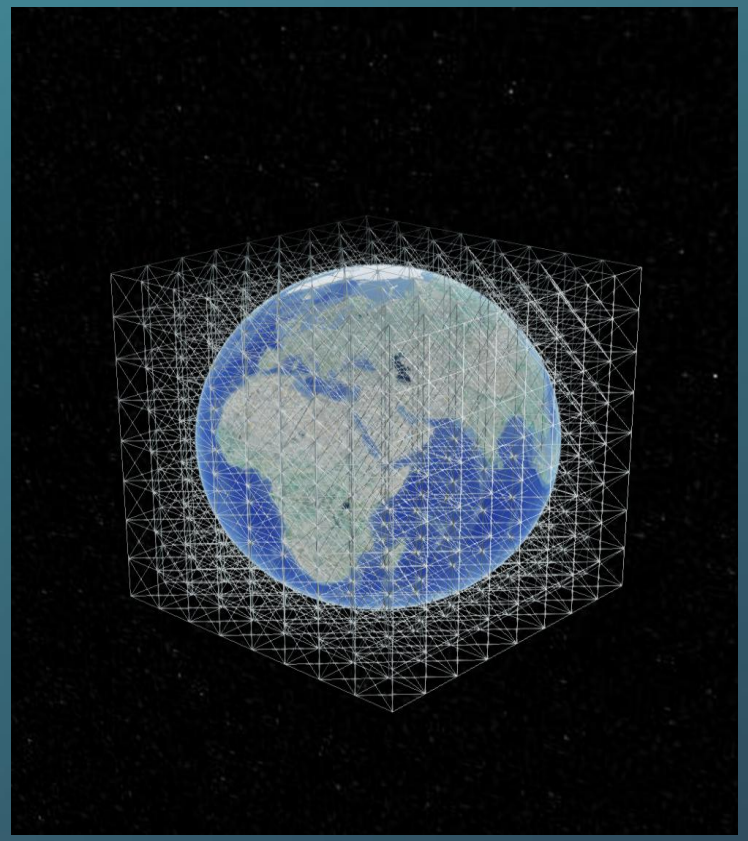


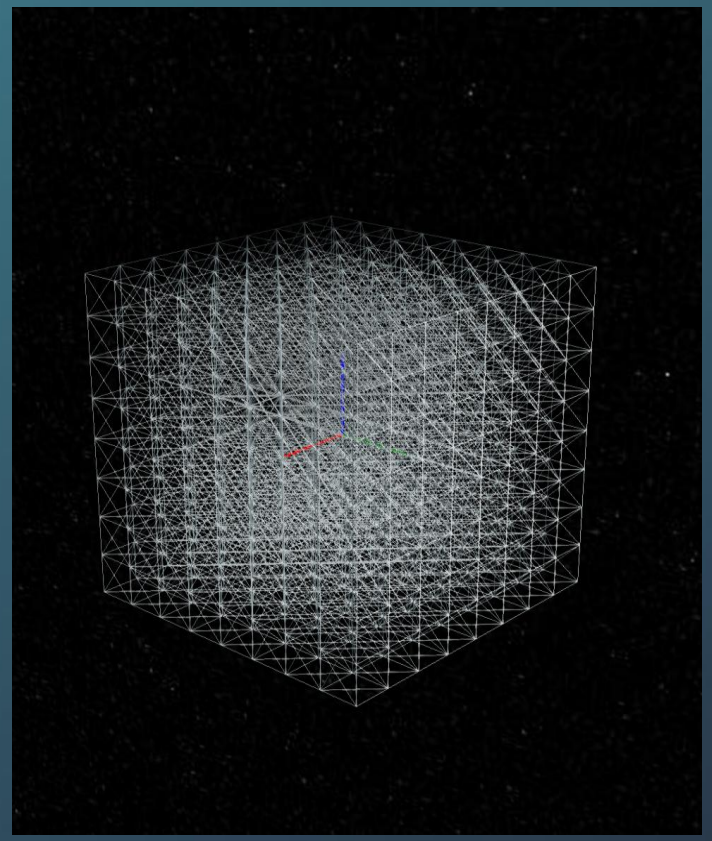
<Intensity>

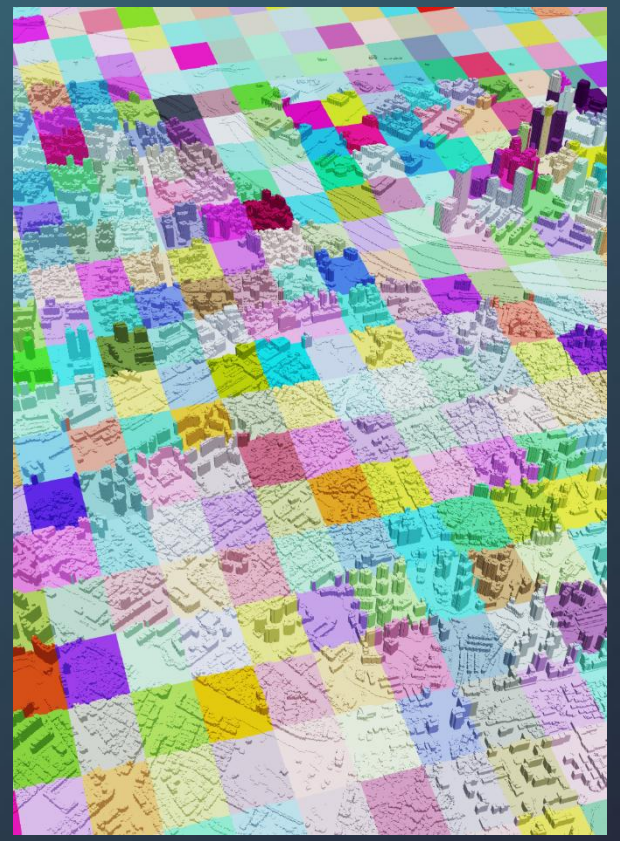
<Classification>

ECEF coordinate system support

Support ECEF Coordinate System







4. Things to Do Moving Forward

There is still a long way to go

mago3DTiler

- Improve stability and performance of photogrammetry conversion
- Add automatic billboard LOD generation for i3dm outputs

mago3DTerrainer

- Expand input data types: TIN, irregular point sets, contour lines, etc.
- Support TIN-based terrain generation
- Enable generating terrain data directly as OGC 3D Tiles
- Add geoid correction
- Support additional tiling schemes: WebMercator (in addition to Geographic)

We have priorities, but your money can change the priority!

Show me the money, we'll show the code!!

5. Q&A

Q&A

Gaia3D
The GeoSpatial Company

FOSS4G
#Code the #Earth, KOREA 2025
#Share the #Future

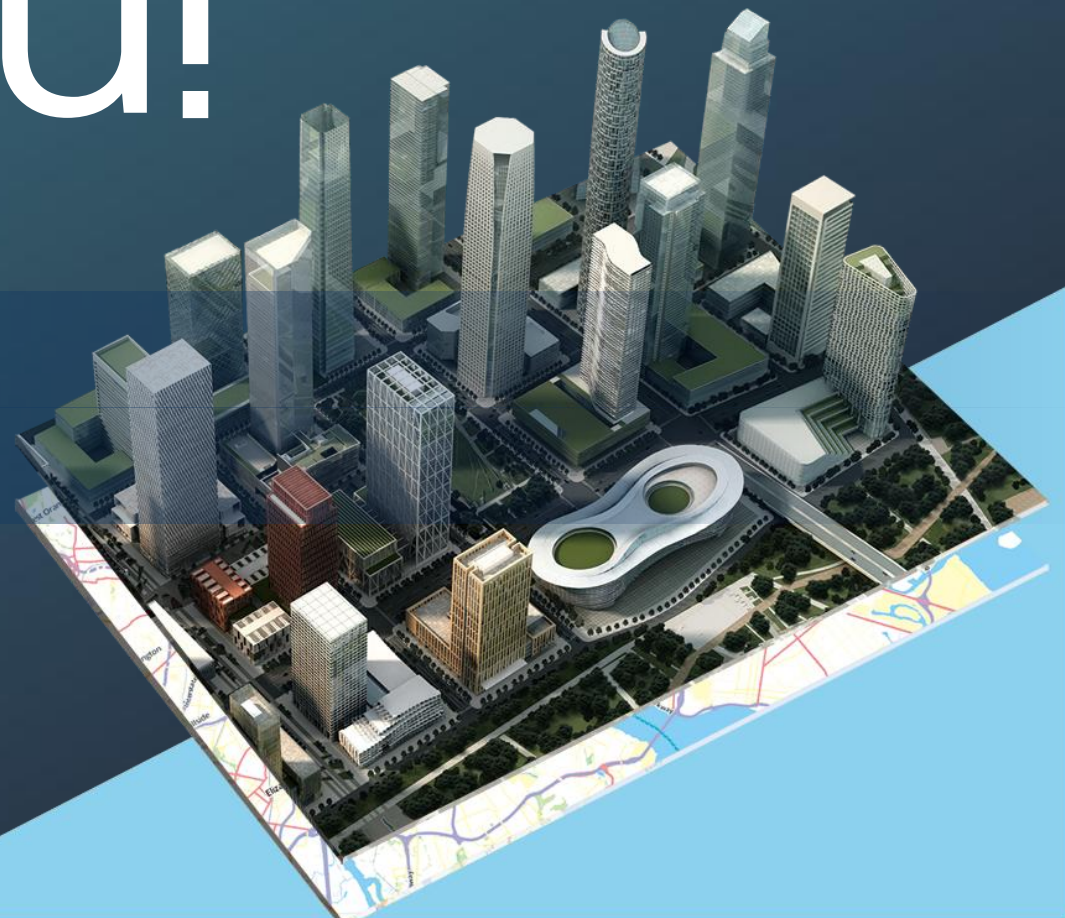
Digital Twin Platform mago 3D

Gaia3D
The GeoSpatial Company

Thank you!

https://github.com/Gaia3D/mago-3d-tiler

https://github.com/Gaia3D/mago-3d-terrainer



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