# Performance Doesn't Grow on Trees.

**Point based rendering for distant tree simplification.**

Cormac Somerville - http://cormacsomerville.com

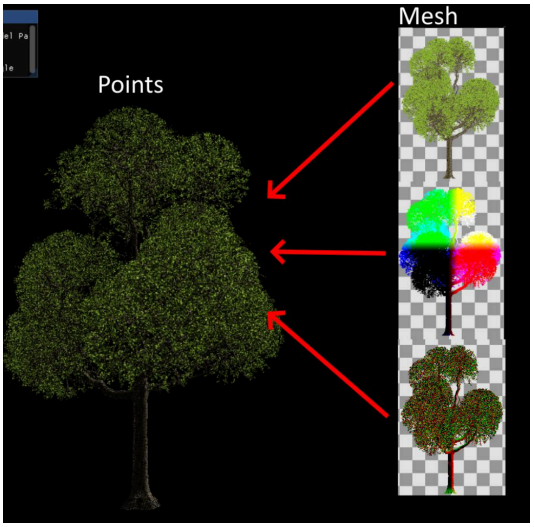
## Overview

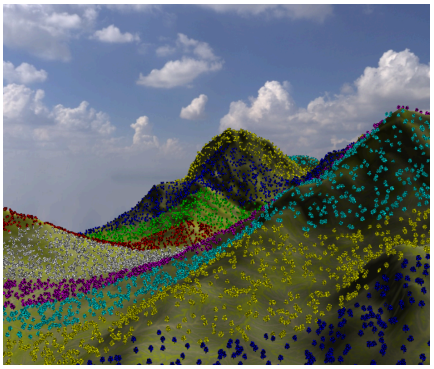
This project looks at the feasibility of using point based rendering and point based decimated models as a level of detail/simplification approach for trees and forests at a distance. Both performance and visuals are assessed with the method aiming to have visual parity with a non simplified version, support typical lighting approaches and be able to render within realtime targets.

## Generation

Point clouds are first generated from a chosen triangle mesh. This allows for ease of integration with existing applications, meaning art creation processes do not need to change and only a minimal pre-processing stage needs to happen.

A visual photogrammetry approach is used over a mesh sampling approach for this. Visual photogrammetry involves taking multiple renders of the object from different angles, and combining these images into a generated point cloud. Geometry buffers allow the capturing of normal and positional data (as well as other data if desired).



## Level of Detail

LODs can be generated from the point cloud in either a discrete levels based approach or a continuous function based approach which leverages the disconnected nature of point primitives.

For each level the total number of points to draw is defined, these points are then drawn from a randomly shuffled version of the initial point cloud.

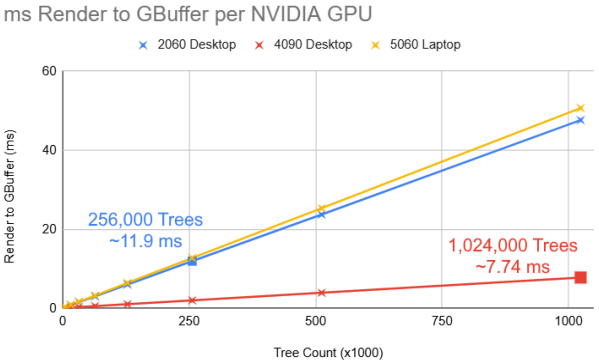
## Rendering

When rendering, the best results are found within a mesh shader approach which invokes a task shader per tree instance, this then decides how many meshlets to draw based on the LOD. This allows the GPU to never execute any mesh shader invocations for points which are outside of the current level of detail. This could be improved upon by clustering multiple trees into one task shader invocation and grouping these into one meshlet for extreme distances.

The point based rendering also supports typical lighting & shadowing approaches which have been developed using deferred rendering. Point based rendering does not eliminate the aliasing issues caused by detailed vegetation. FXAA and TAA have both been implemented to counter this.

## Result

The method shows promising results with realtime render times achievable with a linear relationship between tree count and render time.




*GBuffer = Geometry Buffer*