GDMC 2019 - Outline

Valentin Berlier

This document describes how the generator works. Note that the project is mostly a proof-of-concept as it's currently the result of just two weeks of development.

Building a graph

The generator doesn't directly operate on the selected region as a whole but on a graph of connected subdivisions. We group blocks of similar normals together to form sections that are relatively flat and can be oriented in any direction. This makes it possible to isolate sections based on the slope of an area, and allows us to separate the side of a mountain from a plateau for instance.

The subdivision process begins by computing the height map of the selection. We iterate over the x and z axis and register the highest block in every column. However, the highest block is not necessarily the ground: it may also be a leaf block from a tree, some tall grass, water, etc… We need to compute the "terrain" map by filtering all the blocks that we don't consider to be part of the ground from the height map. Now that we know the y coordinate of the ground for every block in the selection, we can compute the normal vector of each block. For every block, we take the average height of the blocks surrounding each corner and compute the normal based on the four vertices.

In order to group blocks based on their normal, we pick a starting point and then expand outwards while the normal of the neighboring blocks are within a certain threshold, or until we reach a configured size. The section is discarded if it isn't large enough. We repeat the process until all the blocks in the selection have been consumed. Every section is added as an isolated node to an initially empty graph.

Right now the graph holds all of our subdivisions, but so far we still haven't connected them. The next step is to form connections between adjacent sections. To do that, we essentially compute the perimeter of the convex hull of each section, and add an edge to the graph between the section and any other section that intersects the convex hull. This way, all the adjacent sections are now connected in the graph.

The goal is to use these edges to build paths between sections. However, we can't currently use the graph as it is because each section is directly connected to every single adjacent section: there's too many connections. The first cleanup step is to merge sections that are too close to each other. We'll also merge sections that are near the edge of the selection. This way we reduce the number of sections and edges on the sides and make the center of the selection comparatively more densely populated.

Now, because there is still a lot of extra remaining edges, we'll delete every edge that forms a triangle in the graph. We're going to remove edges that connect nodes that are already indirectly connected through another adjacent node. However, we don't want to remove these edges randomly. The best option is to always remove the edge that forms the longest side of the triangle. This makes for more natural, less spiky connections. We iterate over every edge in the graph, from the longest one to the shortest one, and proceed to remove them from the graph if the nodes have an adjacent node in common.

Populating the graph

Our graph is now ready to use! We're going to build the houses and wheat fields first. We iterate over every section in the graph and turn it into a house or a field depending on how flat the surface is and how far away it is from the center of the selection.

Building houses is a bit tricky because their layout is completely dynamic. We first need to compute the available space we have for building the house by taking into account the environment. This will help us make decisions about the position and size of the house extensions. Houses also adapt to the slope of the terrain: houses built on the side of steep mountains will tend to be smaller than the ones built on flat ground.

Wheat fields are a bit different than houses in the sense that they don't generate per section but rather per group of adjacent fields. Farmland and crops are placed on the combined convex area of all the adjacent fields. The same principle applies to windmills: because there can only be one per group of adjacent fields we'll never end up with two windmills right next to each other.

The last step is to connect our sections. We use A* to draw a path for every edge in the graph while avoiding buildings, water and slopes that are too steep.Whenever possible, we also try to place slabs to facilitate moving up and down medium slopes.