Our algorithm is a conceptual exploration of the idea "What if one were to design a Minecraft settlement by explicitly following a traditional city planning approach?"

In the video “An urban planner reviews Minecraft cities”, urban designer Dave Amos reviews settlements built in Minecraft from a city planning perspective. [ https://www.youtube.com/watch?v=y\_RibZPy72g ] Mr. Amos analyzes several different player-built cities as well as last year's GDMC winner. In his review, Mr. Amos compares and contrasts the way that Minecraft cities are designed versus the considerations a real-world city planner might have.

Watching the video begs an interesting question: If one were to design an algorithm to mimic a city planner's methodology, could the algorithm also mimic the output? Our algorithm seeks to explore this idea in depth.

Our algorithm takes the following steps to build a settlement:

1. First, the algorithm prepares a Geological Survey report. The survey maps the topology, analyzes the surface elevation, and identifies and labels important land features such as mountain peaks and calculates their isolation and prominence. It also maps vegetation, soil types and other geological features as would commonly appear on a US Geographical Survey report.
2. Next, the algorithm prepares a Hydrographic Survey similar to those used by organizations such as FEMA. It starts by mapping the watershed. Using this information, it identifies likely flood zones and important water features such as irrigation channels and waterfalls. It identifies protected wetlands and coastal areas that may have important commercial or recreational value.
3. Using the information from the Geological and Hydrographic Surveys, the algorithm performs a Property Assessment. The Property Assessment seeks to quantify the existing land use as well as the resource potential of the site. It determines which areas have high agricultural, forestry or mining value. It also produces a weather assessment and estimates the construction buildability.
4. The next step is to produce a Municipal Development Plan. The development plan outlines areas where the city expects or desires growth based on the information from the property assessment report. The points of interest map proposes locations for housing developments, shopping centers, waterfronts and important agricultural zones.
5. The results of the Municipal Development Plan are then used to develop a Transit Plan. The transit plan proposes a transportation network that will connect the points of interest where the city expects growth. The trips per day are estimated for each point of interest. This information is used to plan the needed road capacity. Care is taken to reduce costs by minimizing expensive projects such as bridge construction.
6. The Zoning Plan acts as a virtual “Country Recorder”. The newly annexed land is divided into subdivisions, which are then parceled and registered. A map of the parcels is produced. Each parcel is assessed an estimated tax value. Easements are recorded so that private driveways or local roadways can be constructed later. Finally, each parcel is assigned a zoning code to indicate the permitted land uses.
7. With the planning stage complete, the transit authority begins levelling and grading the roadways. The roadways are surfaced and any bridges or other infrastructure is constructed.
8. A Subdivision Developer is assigned to each subdivision. The Subdivision Developer serves as a master planner for a geographically contiguous sub-region that shares common features and connectivity.
9. Each Subdivision Developer assigns each parcel to an appropriate architect. The architect develops a floorplan for the home or other structure to be placed on the parcel. The floorplan is realized by means of a cellular automata with rules customized by the architect, subdivision developer and an “architectural styles” community guidelines document.
10. The home is then constructed by the architect with the aid of a roofer that serves to solve the complexities of the roof shape.

Note: Due to the rather large task of creating the series of reports needed to performing even a cursory municipal plan, the algorithm is far from complete. It is capable of building a basic settlement; but many, many parts have not been implemented such as municipal buildings or roof shingles. However, even in its (woefully) incomplete state, the algorithm still manages to demonstrate a number of strengths and unique features that would be well-worth exploring in a longer development time frame.

We believe these are the key features of value:

1. Greater adaptability because choices are not random. Every choice is made for a known reason.
2. Reasoned choices lead to emergent behavior. For example, player-built structures such as existing villages are considered “interesting” by the algorithm. Likewise, the transit planning system assigns a weighted preference to potential roadways that require less terraforming. This has the emergent result that the transit system tends to connect new roadways to existing player-built roadways without needing to explicitly program this behavior.
3. Because the system attempts to adapt to what is there, it is far more able to cope with obstructions such as player-created structures and odd terrain.
4. Feed forward design leads to second-order relationships. For example, settlements that solve the zoning equation by paving over desirable farm land are assumed to be more modern. Modern societies cut costs; one way this is demonstrated in the algorithm is by attempting to reduce the number of bridge piers. If the number of piers falls below the needed support capacity for the bridge when traffic is considered, the bridge architect will recognize this and convert the bridge to a suspension bridge to compensate for the additional load. This has the emergent result that large cities that pave over a lot of farm land have more suspension bridges without an explicit relation.
5. The automata portion is highly parallelizable and would be an ideal candidate for GPU processing. Research note: It would not be unreasonable to convert the imperative portion of the algorithm to an automata for the entire reporting phase!
6. The algorithm is not Minecraft-specific. While the hard-coded implementation does rely on knowledge of block types, etc., the basic concepts will work equally well with any other platform including real-world GIS data.

In summary we believe, with more development, there is a lot of potential with this approach. More importantly it provides great insight into the city planning process.

Lisa Carter

Bryan Carter

artcodeoutdoors@gmail.com