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Final Major project

Progress report

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Background

I want to generate worlds to simplify and streamline world creation for D&D (?)/ fantasy table top roleplaying games(rpg). I will be using procedural generation to generate a map with terrain and biomes, with stretch goals of implementing resources linked to the environment and generating settlements based on said resources. This map will be presented similar to Skyrim’s world map (fig 1). But in a much more stylised and low poly envisionment which would not include foliage.

I’m doing this project to gain a deeper understanding of procedural world building techniques.

I think this fits the course as I believe it’s technically challenging enough.

Overall Aims

* Gain a deeper understanding of procedureal techniques
* Simplify world creation for fantasy table top rpgs
* To generate a world map with biomes

Objectives

* Research approaches to biome generation and the corresponding algorithms
* Chose tools based on existing libraries for chosen algorithm
* Start planning implementation based on research
* Implement continents
* Implement terrain
* Implement biomes

Stretch goals

* Enforce biome adjacency rules; no snow directly adjacent to tropical forests

Description of research/prototyping completed

* Section on research/prototyping done at this point

Project Specification

* Fully detailed description of the “product” use short clear descriptions with measurable values
* An application capable of generating 3D maps for a fantasy world
* Which will have biomes and visible terrain

Discussion of potential solutions - Algorithms/approaches

* Tectonics
  + <https://undiscoveredworlds.blogspot.com/2019/02/basic-continents.html?m=0> use of tectonics to form mountain ranges
  + Strengths
    - Creates realistic mountain ranges by simulating tectontic plates colliding
  + This approach doesn’t use real tectonics at they’ve very complex, they simply created blobs for continents. Doesn’t actually explain how mountain ranges are completed.
* Voronoi
  + <http://www-cs-students.stanford.edu/~amitp/game-programming/polygon-map-generation/> The original source which introduced me to the concept, which breaks down an approach of how to generate a map using this methodology. This involves the use of whittaker diagrams which are used to model biomes.
  + In my research I found many similar projects that all used this article ^ as the basis, <https://mewo2.com/notes/terrain/>, <https://azgaar.wordpress.com/2017/03/30/first-post/> which is based of prior link which is in turn based off of  ^ above, same as prior <https://heredragonsabound.blogspot.com/2016/10/welcome.html>
  + Reason chosen
    - Many great examples for how it works
    - Many other projects that have reached my desired result via this method
    - Libraries exist for algorithms I want to implement if I were to fail implementation
  + <https://dl.acm.org/citation.cfm?id=10549> the original publication of the Fortune's algorithm which is used to create voronoi diagrams. Very difficult to understand due to its’ pure math existence. ( no pictures :( )
* Hex based generation
  + <https://forhinhexes.blogspot.com/2018/04/motivation.html> This has a very similar end goal as my project but represents thre map differently from how I want.
  + Desired generation to be less rational less “smooth” as they believe it will represent life better due to it’s unpredictable nature. I believe their dislike for seeds and random numbers is due to their lack understanding of how they impact generation, their issues are due to how the data is handled not the seeds themselves. As the data could be handled to generate those irregularities by adding a small chance for them to appear at the point that element is generated.
  + Also using tectonics
    - No interested in tectonics themselves but are interested in the boundaries that are the result of them, convergent and divergent which are used to generate mountains and coastlines respectively.

Discussion of tools and technologies

* Choice of language
  + C++ & C# I’m comfortable using
* Use of engine? - most likely so I can better focus on generation and not waste time with rendering etc.
  + Unity
    - 60k verts max per generated mesh. ( evidence of this? )
    - I’m familiar with this engine as I’ve made multiple games using it and have created procedural world using a height map and perlin noise. <https://thedarkmagi.itch.io/procedural-world-generation>
  + Unreal
    - I’ve used twice but only with blueprint, so I’m not familiar with how c++ is implemented
  + Godot
    - Never used
  + Gamemaker
    - Uses game maker script which I would need to learn
  + Heaps.io
    - Uses haxel language would need to learn it
  + Use an API dx11 etc.
    - Would introduce many setbacks and complications like having to program rendering etc.
* Libraries available to me? Which languages etc
  + Delaunay libraries
  + <https://github.com/jceipek/Unity-delaunay> c#
  + <https://github.com/SirAnthony/cppdelaunay> c++
* Desired features
  + Creation of voronoi diagrams
  + Creation of voronoi diagram onto a mesh
  + Delaunay implemented

|  |  |  |  |
| --- | --- | --- | --- |
| Source | Feature complete | Compatible | Easy to use/understand |
| <https://github.com/jceipek/Unity-delaunay> | Appears so | Apart from demo project. yes | Seems it? |
| <https://github.com/Ranguna/Triangle-NET-Unity-Port> | No Delaunay triangulation I believe? | Yes | From a brief look I don’t know how it works/how to use it |
| <https://github.com/eppz/Triangle.NET> | no |  |  |
| <https://github.com/PixelsForGlory/VoronoiDiagram> | No Delaunay triangulation |  | The installation process is unclear making it unusable |
| <https://github.com/OskarSigvardsson/unity-delaunay> | Delaunay and Voronoi. Voronoi is generated from Delaunay, I don’t know if that convenient based on my current approach |  |  |

Discussion of software dev methodology

Answer these

* How to do you plan to begin the project?
* How will you organize the plan and weekly workload?
* How frequently will you re-evaluate progress compared to the plan?
* How will risks be managed?

|  |  |  |
| --- | --- | --- |
| Risk | Likelihood | Backup plan |
| Difficulties implementing chosen algorithm | high | Use pre-existing libraries to allow the project to continue |
| Engine having unknown limitations | Medium | Features may have to be removed if a solution to bypass the limitation cannot be found |
| Libraries being incompatible with recent versions of unity | medium/high | Find another library or reconsider use approach/engine to use |
| Libraries not having all required features | Medium | Find other ones. |

Discussion of project management tools and metrics

* Research – 5 days
* Comprehend research and understand algorithms - 4 days
* Generate biomes – 2 - 4 weeks possible breakdown of generation based on current level of research.
  + Generate tiles (with Voronoi)
  + Assign tiles biomes
  + Enforce biome adjacency rules (no snow next to tropical forest etc.)
  + Biome blend/transition tiles
  + Heightmap implemented in relation to biome type (mountains high, sea low)

Stretch goals - 2 weeks

* Assign resources to tiles
* Spawn cities with locations based on resources
* Scale cities based on available resources

Resource implications

Testing

High level overview of classes that may be required

A high-level class diagram with inheritance, composition and aggregation

High level flow diagrams and pseudocode

Approximate indication of the ordering of operations

Appendices

Reference List and Reading list

Literature review

<http://galaxykate0.tumblr.com/post/139774965871/so-you-want-to-build-a-generator> overview on proj gen

<http://www-cs-students.stanford.edu/~amitp/game-programming/polygon-map-generation/> article with an approach I’d like to take

<https://azgaar.wordpress.com/2017/06/30/biomes-generation-and-rendering/> biome generation

<https://arxiv.org/abs/1707.03383> paper on terrain generation

<https://dl.acm.org/citation.cfm?id=1814259>    
Towards multiobjective procedural map generation

<https://pdfs.semanticscholar.org/5961/c577478f21707dad53905362e0ec4e6ec644.pdf> Realtime Procedural Terrain Generation  -- this looks like a very good source

<http://slideplayer.com/slide/3447433/12/images/14/Robert+Whittaker,+Cornell+Uni..jpg> biome chart

<http://www.jgallant.com/procedurally-generating-wrapping-world-maps-in-unity-csharp-part-1/> a way to implement biomes/ world maps    seems like it could be very helpful

<https://forum.unity.com/threads/open-source-procedural-hexagon-terrain.233296/> generate hexagon style terrain like civ

<https://www.gamasutra.com/view/news/315400/Devs_weigh_in_on_the_best_ways_to_use_but_not_abuse_procedural_generation.php> last section talks about how “any tool can be used“

Books:

Procedural Content Generation for Unity Game Development

Procedural Content Generation for C++ Game Development

Procedural Generation in Game Design

<http://pcgbook.com/> a book on procedural generation in games



Figure 1 map from skyrim