Procedural Cities Design Document

Explaining the Procedural Cities World

Procedural Cities uses a system of generated textures to create its complex simulation the world in time and space. These generated textures can be produced at anytime from a set of parameters alway producing the same result.
This paper will attempt to explain this system and to show how it can be used to build up a virtual world using simple functions.

Notation:

Due to the generation system's heavy links to mathematics, I will be using a short-hand for the "combinationImageGenerator" as well as other functions in the following pages.

Notation for a combination image generator:

$[x\ y\ z\ n]$

- $x:$ *x offset of the map*
- $y:$ *y offset of the map*
- $z:$ *z offset* (*time*) *of the map*
- $n:$ *number of iteration in producing the map* (*effectively the zoom level*)

Binary mapping:

This will take a pixel of the image and the set it to completely black if it is below y of completely white if it is above y

$\beta(x,y),\ x \equiv pixel\ value,\ y \equiv cutoff\ value$

Triple mapping:

This will take a pixel of the image and then set it to completely red if it is below y, completely green if it is between y and z, and completely blue if it is above z.

$\gamma(x,y,z),\ x \equiv pixel\ value,\ y \equiv first\ cutoff\ value,\ z \equiv second\ cutoff\ value$

Notation of variable types:

Uppercase variables represent data that is subject to change in the definition of each map e.g.

X in the generation of the terrain map does not equal X in the genreration of the cities map

Lowercase variables remain constant once they are defined e.g.

$t = [X\ Y\ Z\ 8]\ ,\ l = \beta(t, 127) = \beta([X\ Y\ Z\ 8], 127)$
$Where\ X, Y, Z\ are\ equal\ in\ both\ definitions$

Generating the maps

What follow is a full run down of how every required map for the program will be generated.

Segment 1: (All maps in segment 1 are of size 2^8)

Terrain Map:

User as a height map for rendering the terrain.

$t = [X\ Y\ Z\ 8]$

Land Sea Map:

White indicates land while black indicates sea.

$l = \beta(t, X)$

Cities Map:

White indicates city structures.

$c = \beta(l \bullet [X\ Y\ Z\ 5], W)$

Cities Green Space Map:

White indicates a green space (park) in a city.

$g = \beta(c \bullet [X\ Y\ Z\ 5], W)$

City Attractions Map:

White indicates an interesting (unique) attraction in a city.

$$a = \beta(c \bullet [X\ Y\ Z\ 1],\ W)$$

Wealth Map:

Red indicates low wealth, Green indicated medium wealth, Blue indicated high wealth.

$$w = \gamma(c \bullet [X\ Y\ Z\ 4], V, W)$$

Zoning Map:

Red indicates industry, Green indicates commercial, Blue indicated residential.

$$z = \gamma(c \bullet [X\ Y\ Z\ 4], V, W)$$