Ingeniería Matemática
FACULTAD DE CIENCIAS
FÍSICAS Y MATEMÁTICAS
UNIVERSIDAD DE CHILE

Generación de entornos virtuales usando algoritmos estocásticos

Curso: MA4402 – Simulación estocástica: Teoría y laboratorio.

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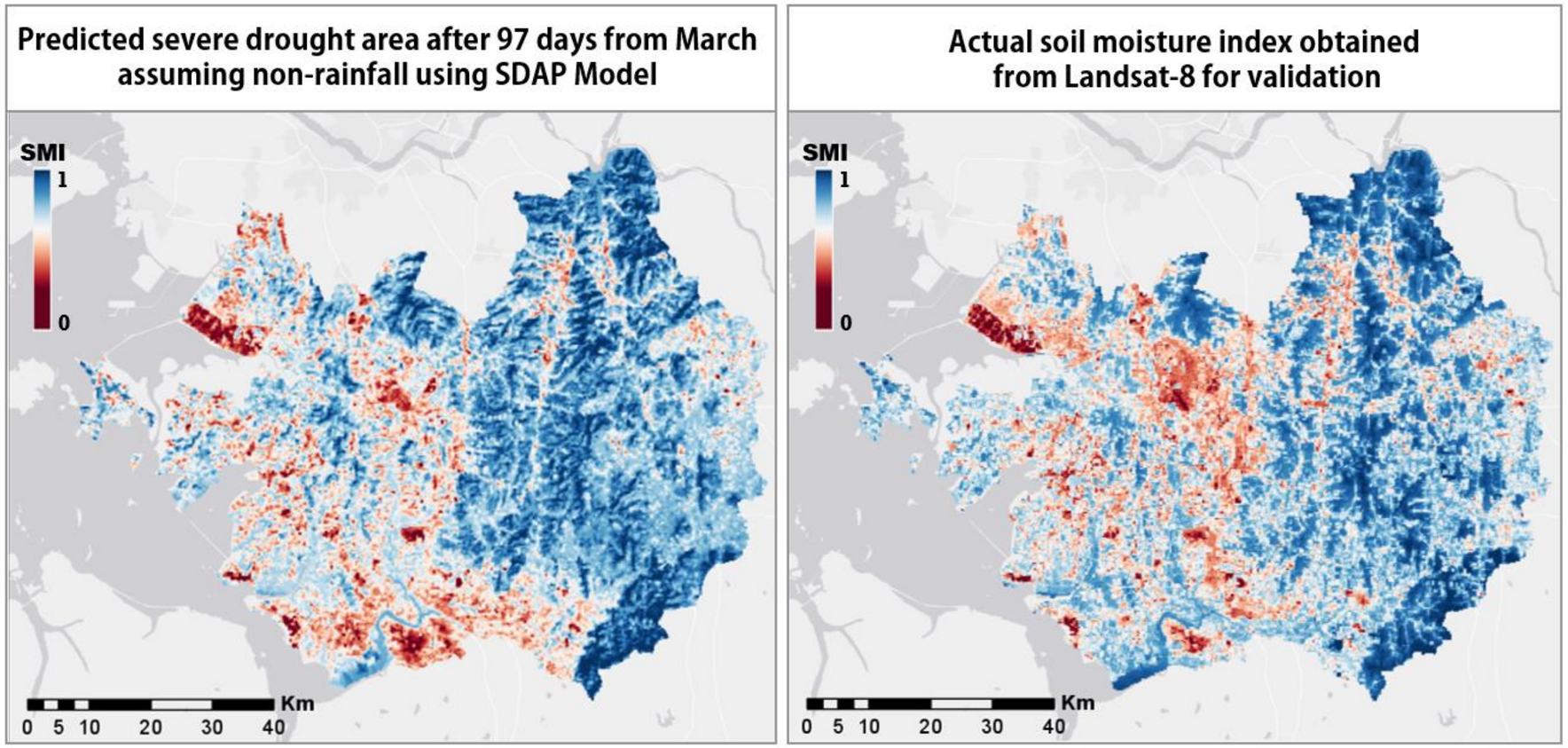
Contexto

La simulación de entornos virtuales es un desafío multidisciplinario

Problemática:

La creación de entornos virtuales manualmente es caro, de manera que es necesario desarrollar alternativas que generen estos entornos para poder entrenar redes neuronales o poder generar contenido procedural:



Propuesta: Usar herramientas estocásticas conocidas

Cadenas de Markov

Simulated Annealing

Pseudocodigo de la Cadena de Markov:

```
función markov_chain_terrain(tamaño, iteraciones, transición_std):

    terreno = initialize_terrain(tamaño)

    por cada _ en rango(iteraciones):
        nuevo_terreno = copiar_matriz(terreno)

        por cada x en rango(1, tamaño-1):
            por cada y en rango(1, tamaño-1):
                vecindario = obtener_submatriz(terreno, x-1, x+2, y-1, y+2)
                nuevo_terreno[x, y] = promedio(vecindario) + normal_aleatoria(0, transición_std)

        terreno = nuevo_terreno
```

Funcion de costo en Simulated Annealing:

$$\text{energía} = \text{Cohesion} - \text{elevación} + \text{promedio gradiente}$$

where:

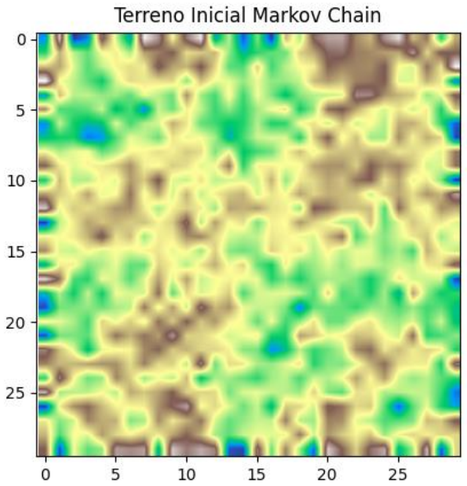
$$\text{Cohesion} = \sum_{(i,j)\in[2,\text{n-1}]^2} \sum_{(a,b)\in[\text{i-1},\text{i+1}]\text{x}[\text{j-1},\text{j-1}]/(\text{i,j})} |(i,j)-(a,b)|$$

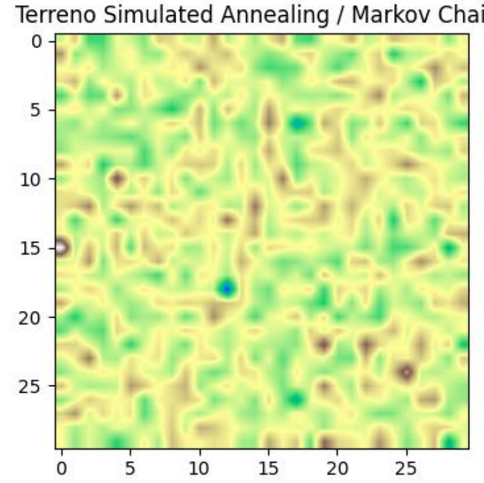
$$\text{elevation penalty} = \max_{(i,j)\in[1,\text{n}]^2}(\text{altura(i,j)}) - \min_{(i,j)\in[1,\text{n}]^2}(\text{altura(i,j)})$$

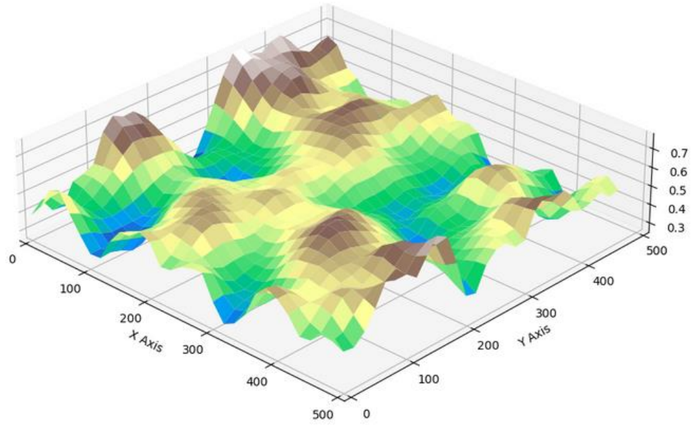
$$\text{promedio gradiente} = \bar{E}(\nabla(matriz))$$

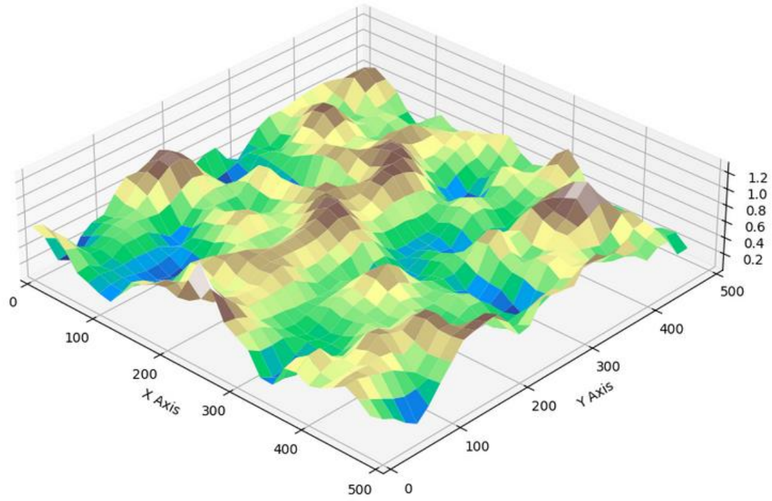
Resultados

Markov Chain

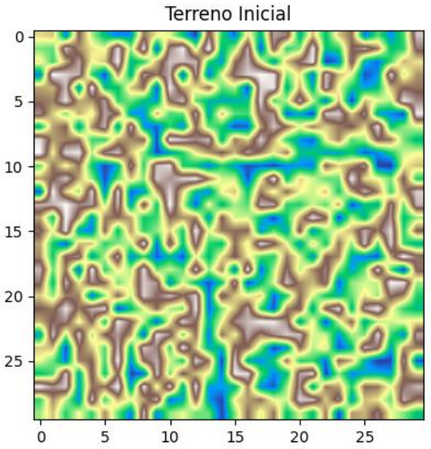


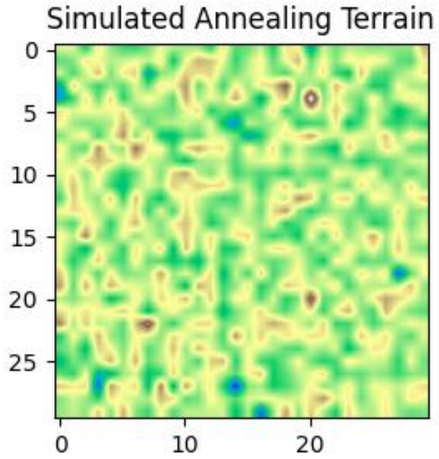


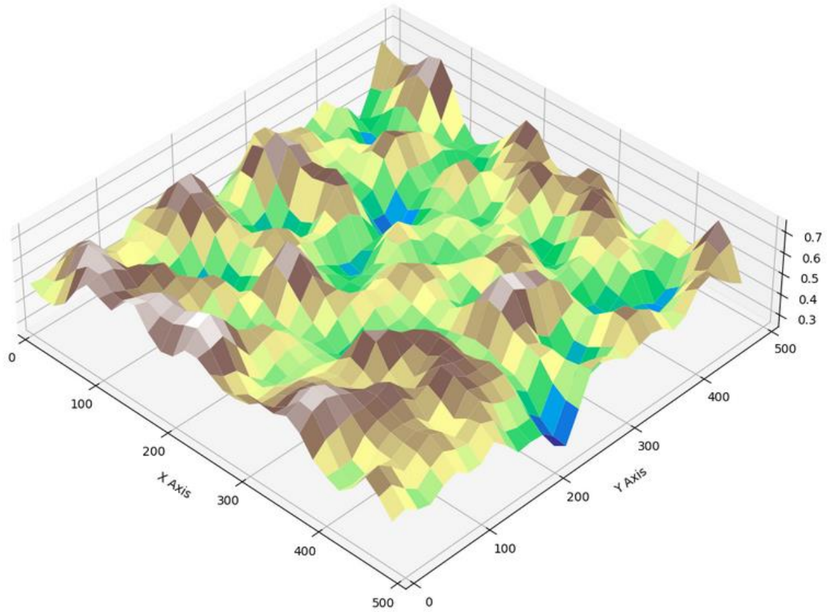


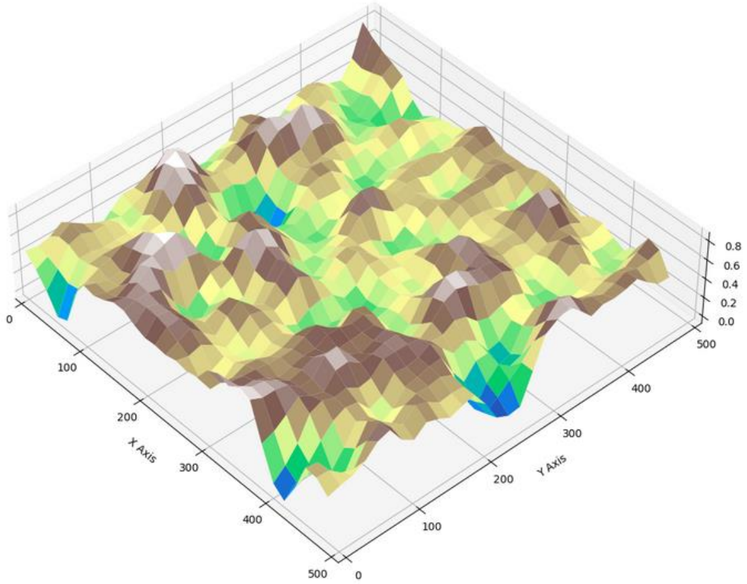


Simulated Annealing solo

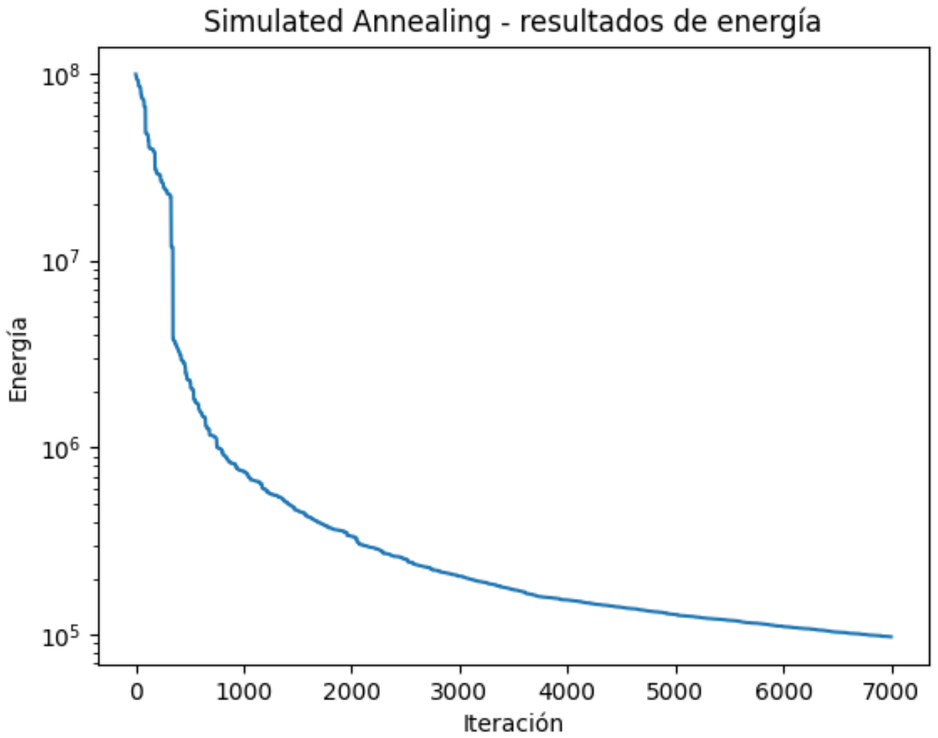




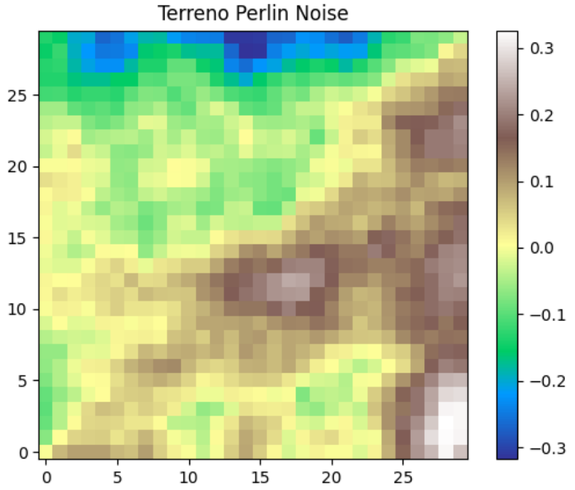


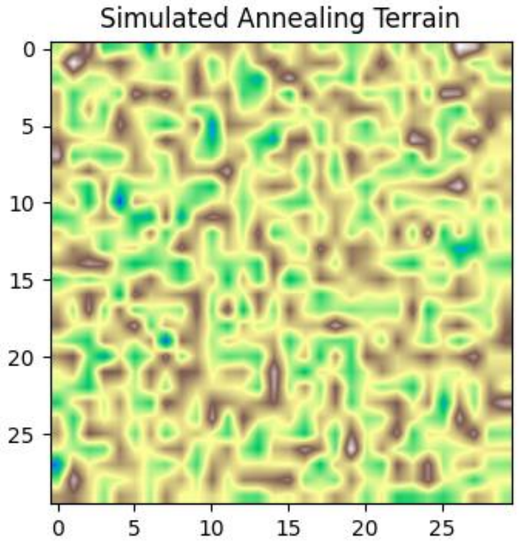


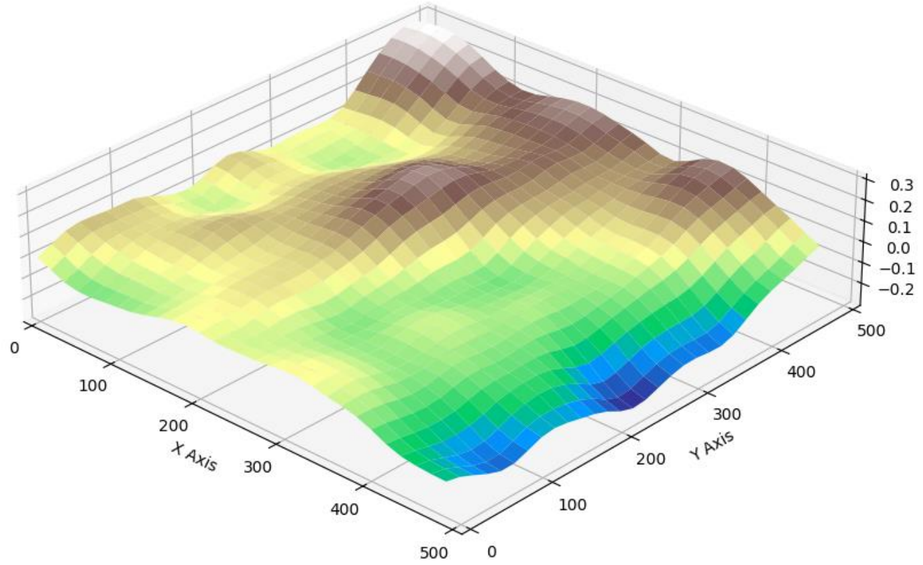
Simulated Annealing: Curva de minimización de energía

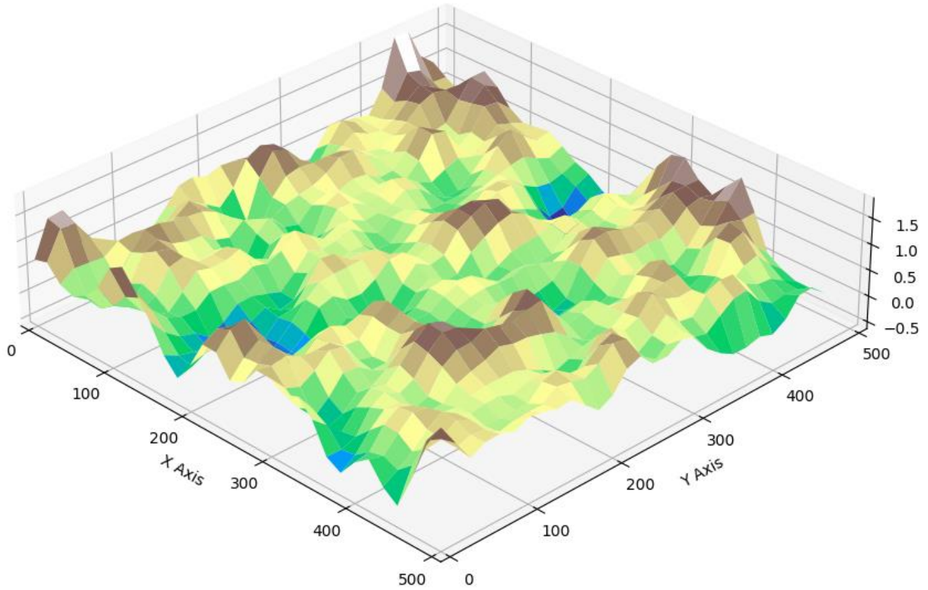


Comparación entre Simulated Annealing y Perlin Noise

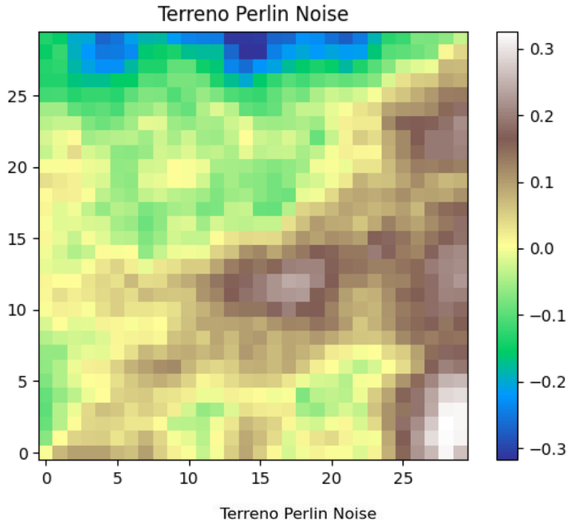


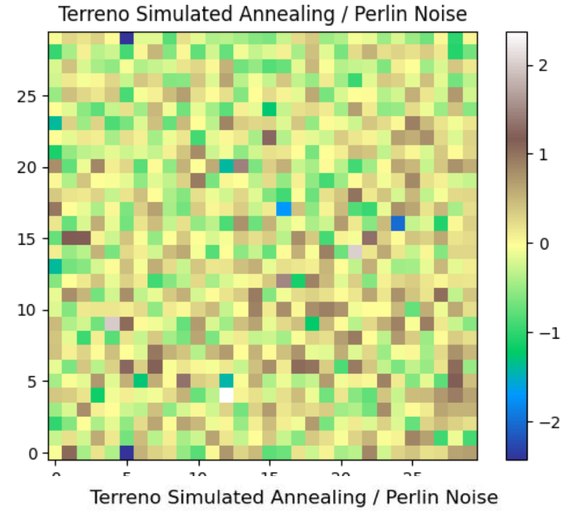


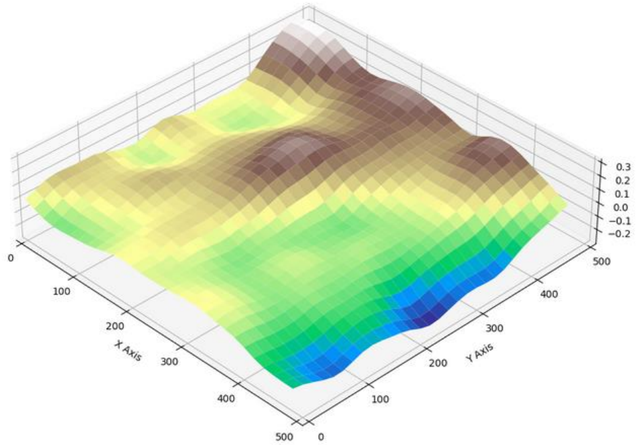


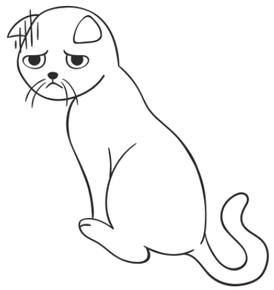


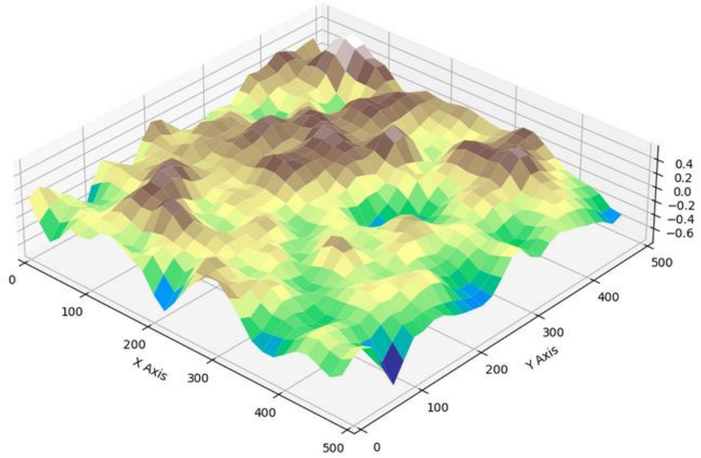
Metodología de Simulated Annealing sobre Perlin Noise

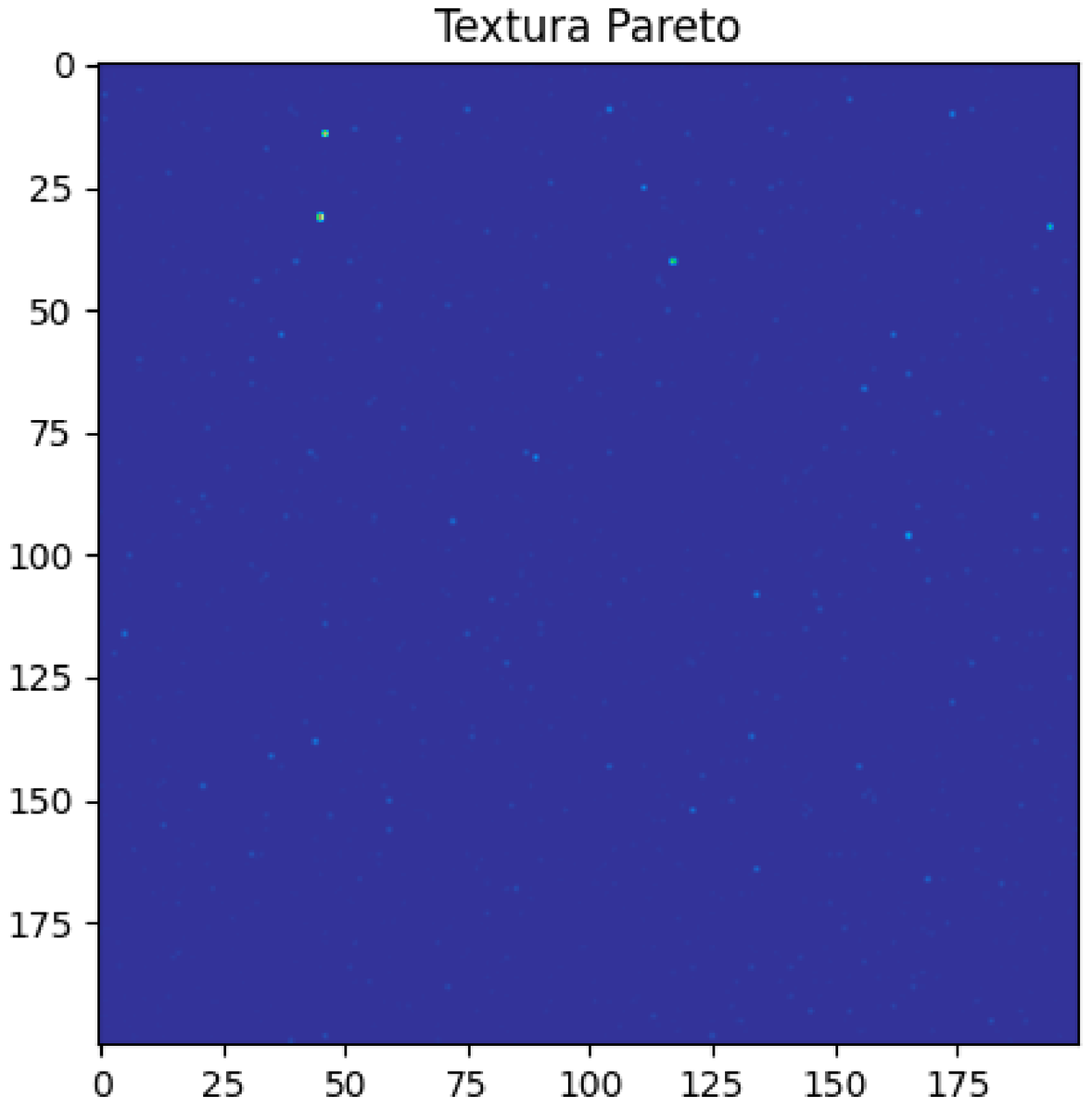


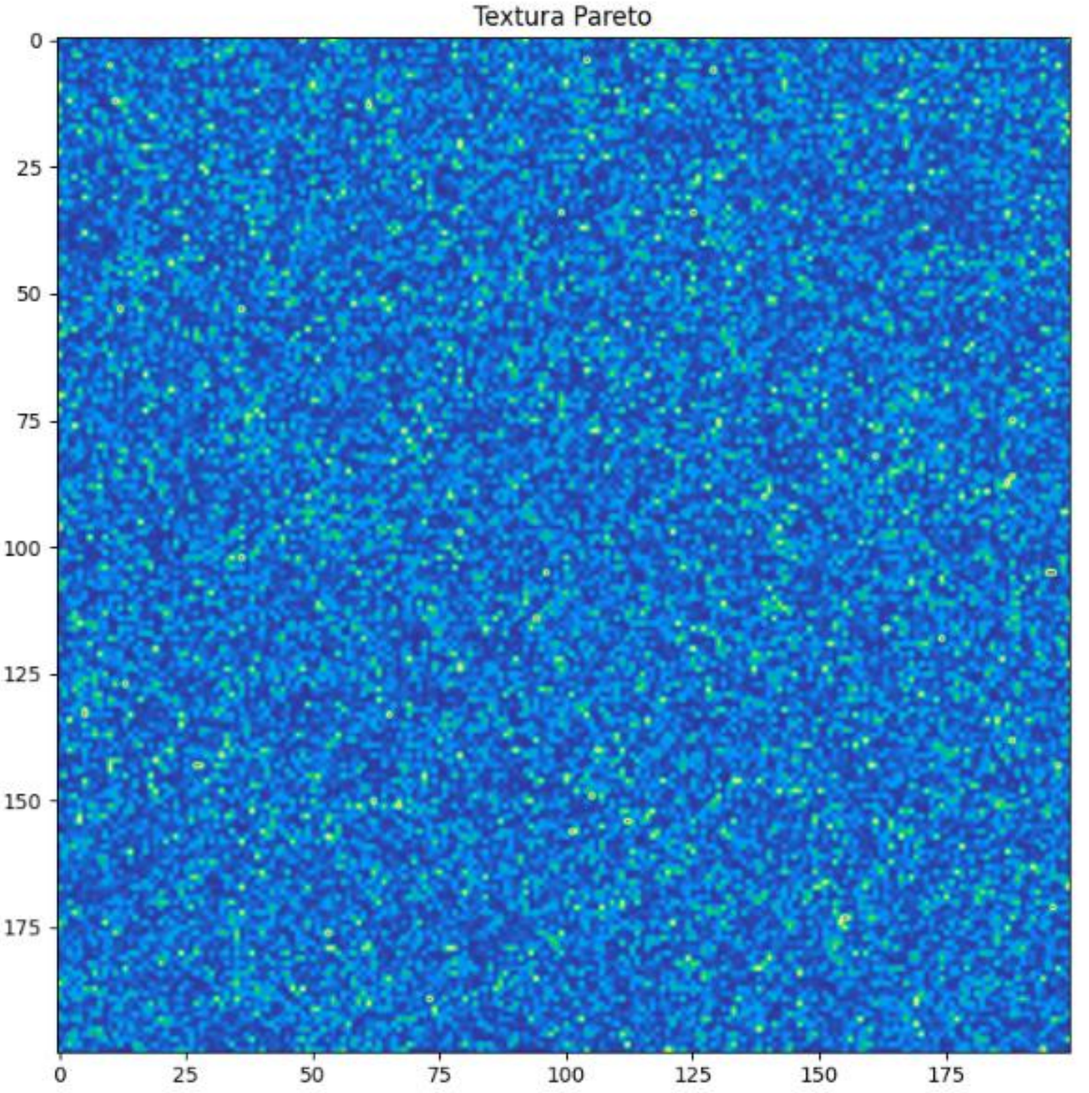









Textura Pareto
0
25
50
75
100
125
150
175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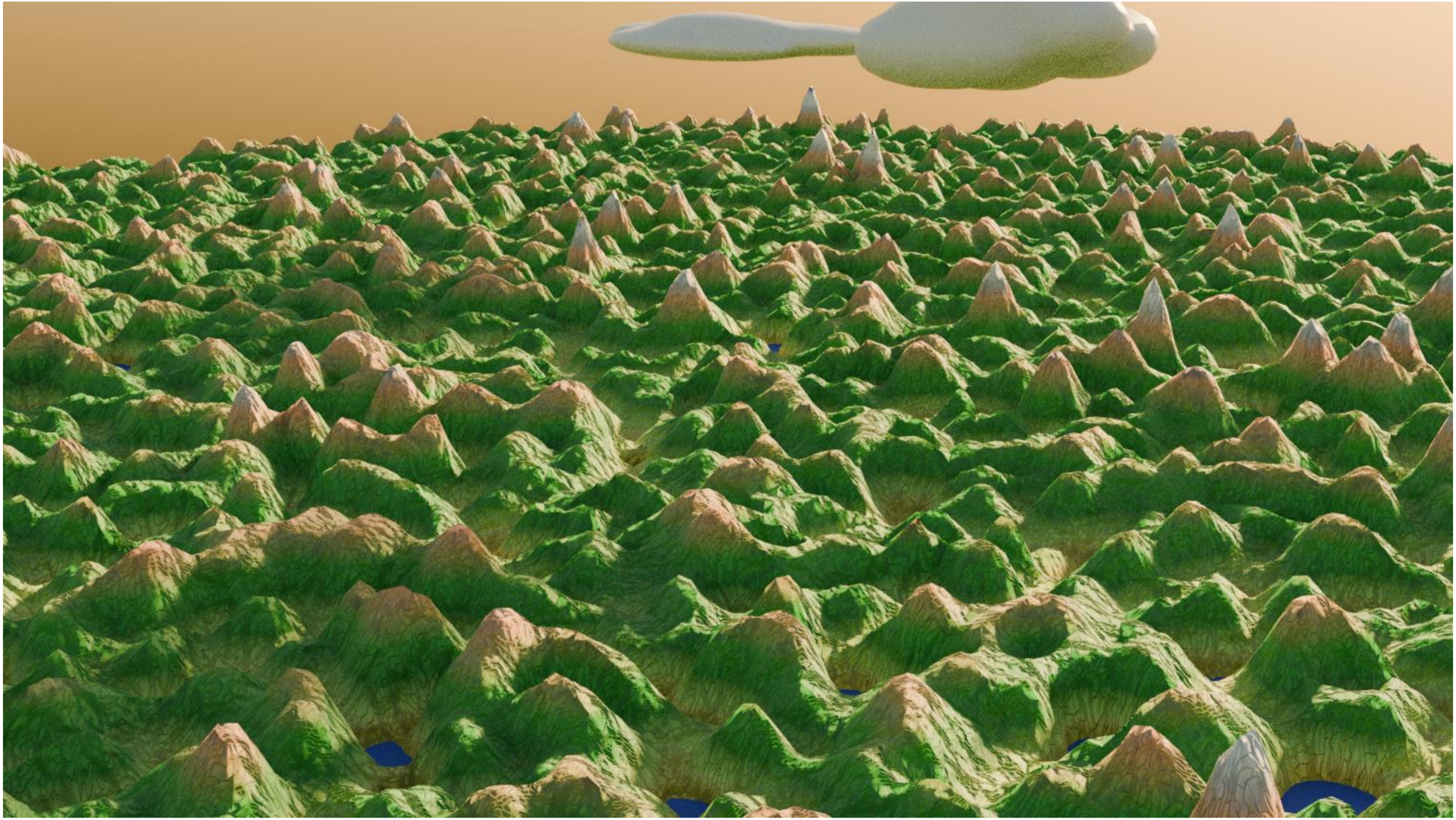

Conclusiones

[1] Fundamentals of Terrain Generation. CMU School of Computer Science. (n.d.). https://www.cs.cmu.edu/ 112/notes/student-tp-guides/Terrain.pdf

[2] Tuomo Hyttinen. *Terrain synthesis using noise*, MS thesis, 2017.

[3] McDonald, N. M. (2019). Markov Chains for Procedural Buildings. Nick's blog. https://nickmcd.me/2019/10/30/markov-chains-for-procedural-buildings/

Muchas Gracias