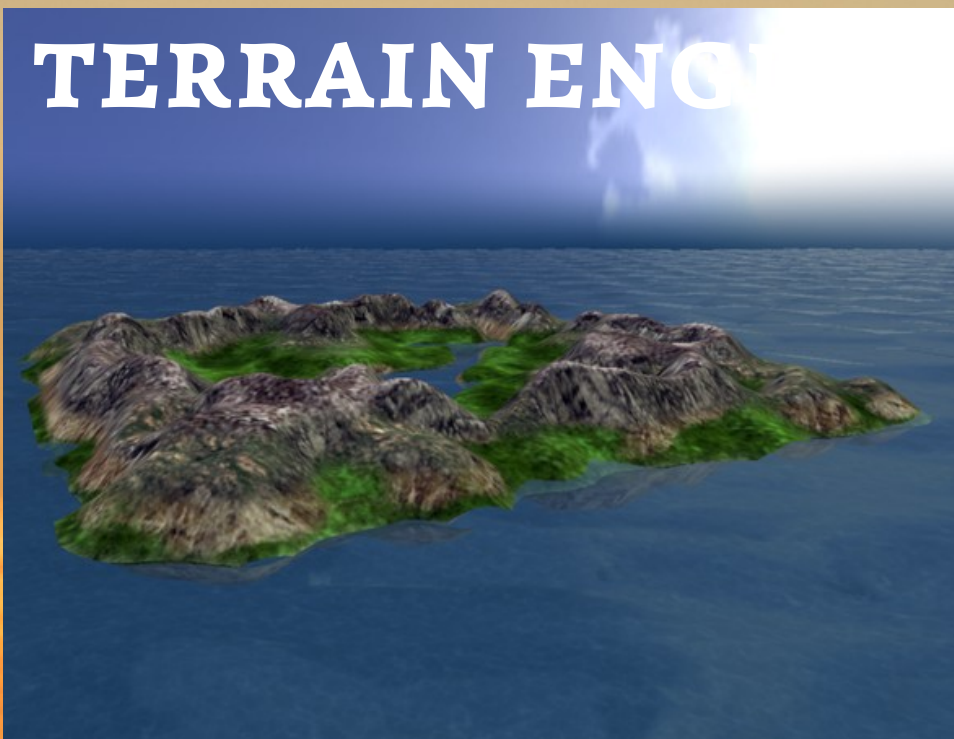


COMPUTER GRAPHICS

Cheap tricks for believable real-time worlds

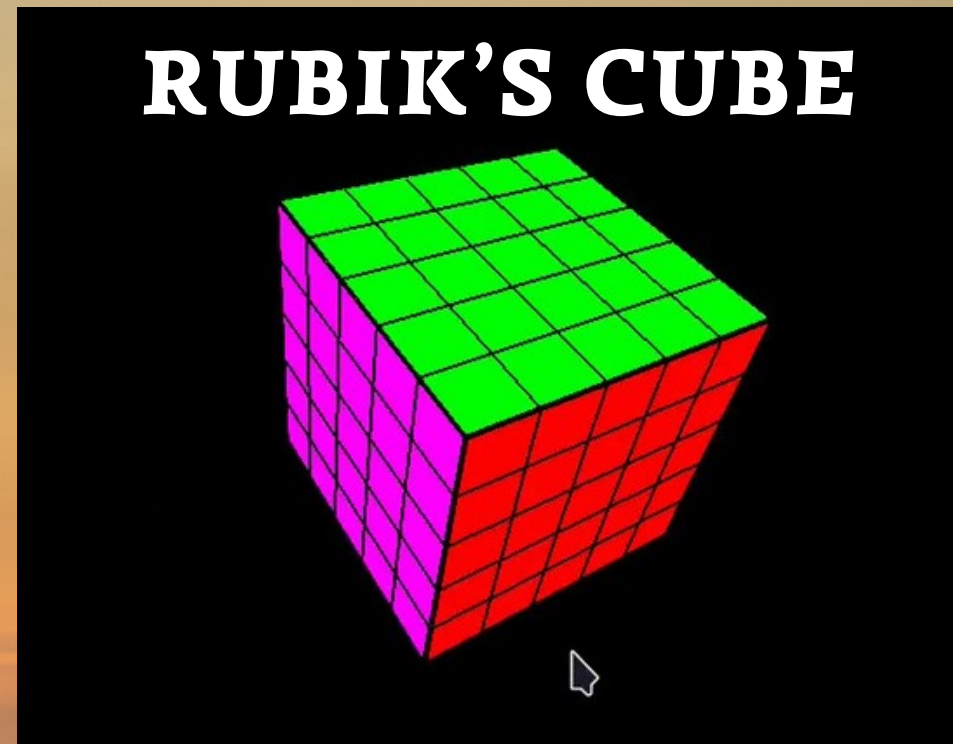
TWO PROJECTS

TERRAIN ENGINE



- Heightmap island, skybox, animated water, reflections, fly camera.
- Goal: sell a big outdoor scene with small, ordered tricks.
- This is the focus of the talk.

RUBIK'S CUBE



- Interactive OpenGL puzzle with per-cube transforms.
- Layer selection, snapping, runtime NxNxN rebuild.
- Hard part: visual transforms and logical layers stay consistent.

ONE FRAME, FOUR PASSES

1. Skybox at far plane



2. Opaque terrain above sea



3. Mirrored terrain below sea



4. Transparent water pass



A 3D rendered rock formation with green moss on a dark teal background. The rock is dark grey and brown with patches of bright green moss. It has a jagged, irregular shape with a central hole. The text is white and bold, centered over the rock.

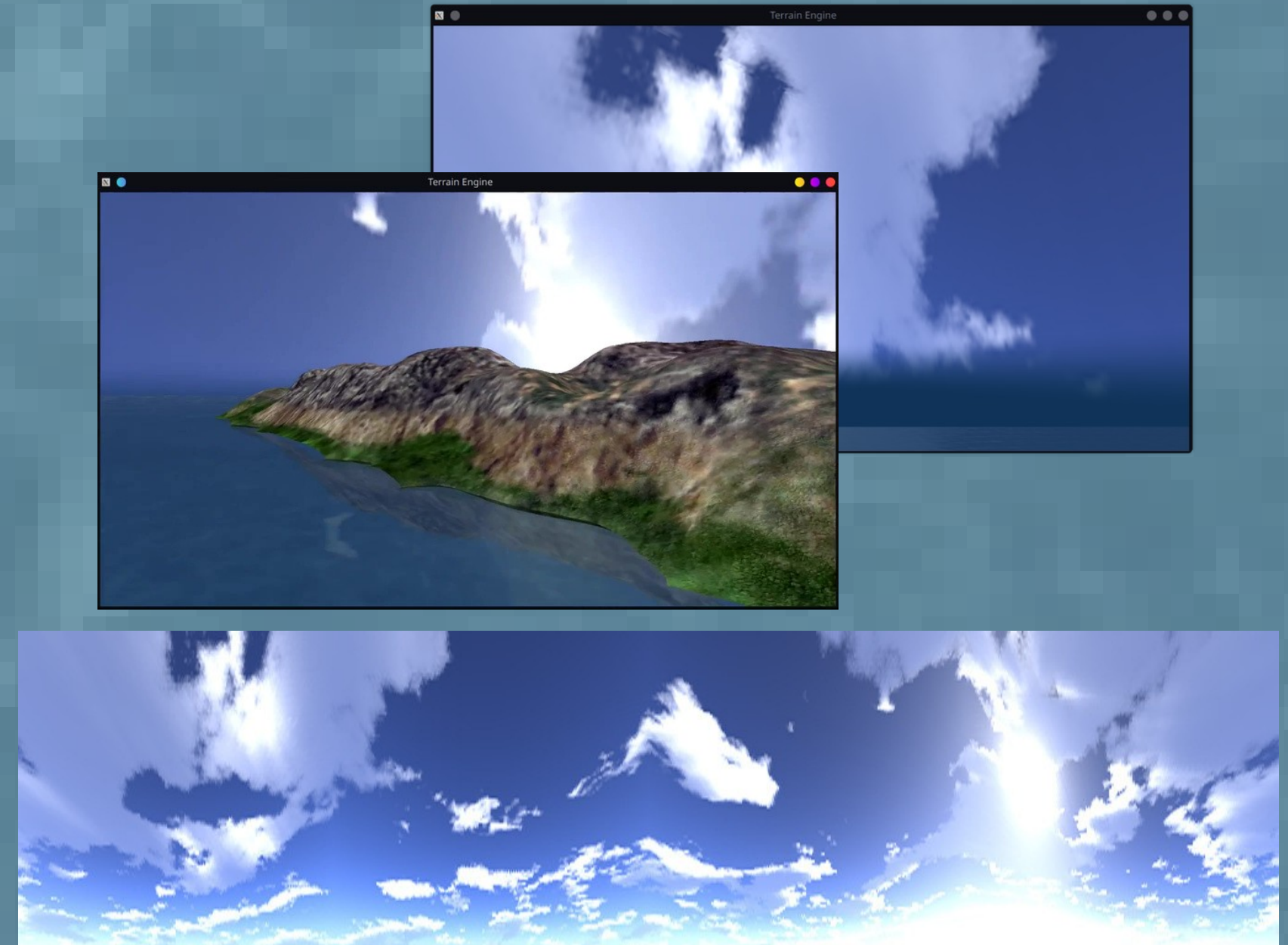
**HOW THIS PROJECT'S TECHNICS
ARE USED IN REAL GAMES?**

SKYBOX

THE ELDER SCROLLS III: MORROWIND – SKY AND DISTANT FOG



TERRAIN ENGINE: FIVE-FACE SKYBOX



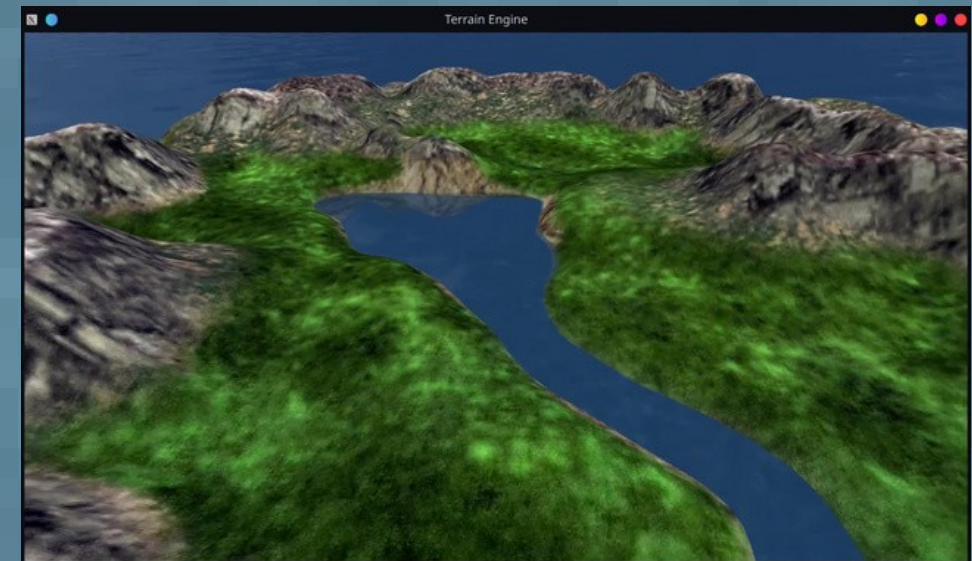
- Both scenes avoid modeling distant mountains, clouds, and skyline geometry.
- I draw five skybox faces and let the ocean/clear color hide the missing bottom.

TEXTURE DETAIL

**RAGE: DENSE WORLD DETAIL CARRIED BY
TEXTURE DATA**



**TERRAIN ENGINE: HEIGHTMAP, BASE
TEXTURE, DETAIL**



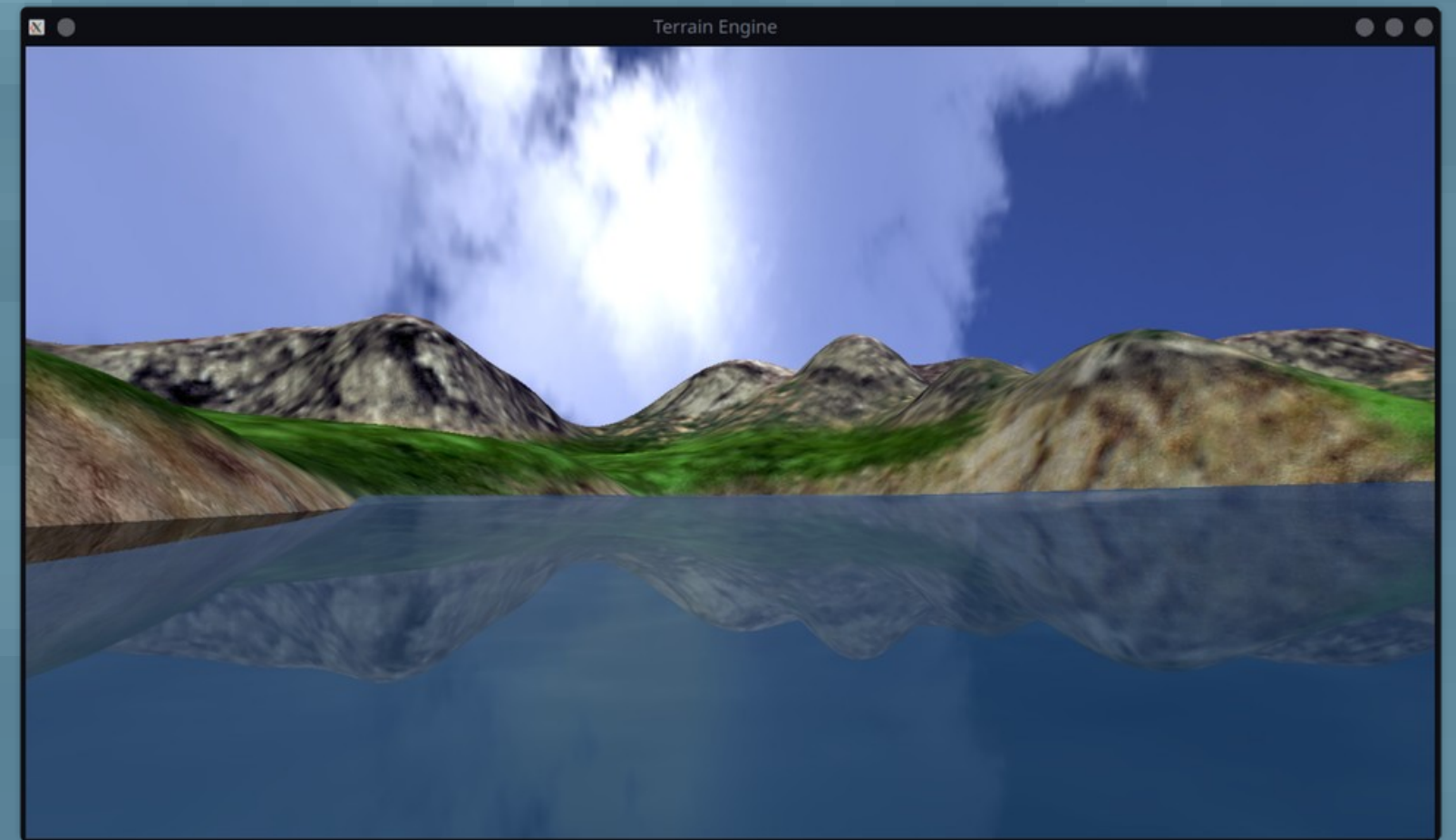
- RAGE/id Tech 5 is a famous extreme of using texture data to carry visible world detail.
- My smaller version: a heightmap image builds the terrain mesh, then a repeated detail map adds close-up richness.
- The trick is the same tradeoff: spend pixels and sampling before spending many more triangles.

MIRRORED WATER

HALF-LIFE 2: WATER REFLECTION AS A HERO EFFECT



TERRAIN ENGINE: REFLECTED TERRAIN BELOW WATER



- The trick is to render a plausible mirrored world only where water can reveal it.
- My terrain is drawn again with $S(1, -1, 1)$ around sea level, then clipped and blended under the water pass.
- The state changes matter: flip culling for the mirrored mesh, keep water transparent, and draw it late.

CHEAP WATER CUES

**TEAM FORTRESS 2: OUTDOOR WATER AS A
BACKGROUND CUE**



**TERRAIN ENGINE: SIMPLE WATER PLANE
PLUS SHADER MOTION**



- A game can reserve expensive reflection/refraction for close or important water.
- My water follows that philosophy: four sine-wave vertex waves, analytic normals, scrolling texture detail, alpha, and a sky cue.
- It looks alive, but it is still a grid, not a real fluid simulation.

BLOB SHADOWS

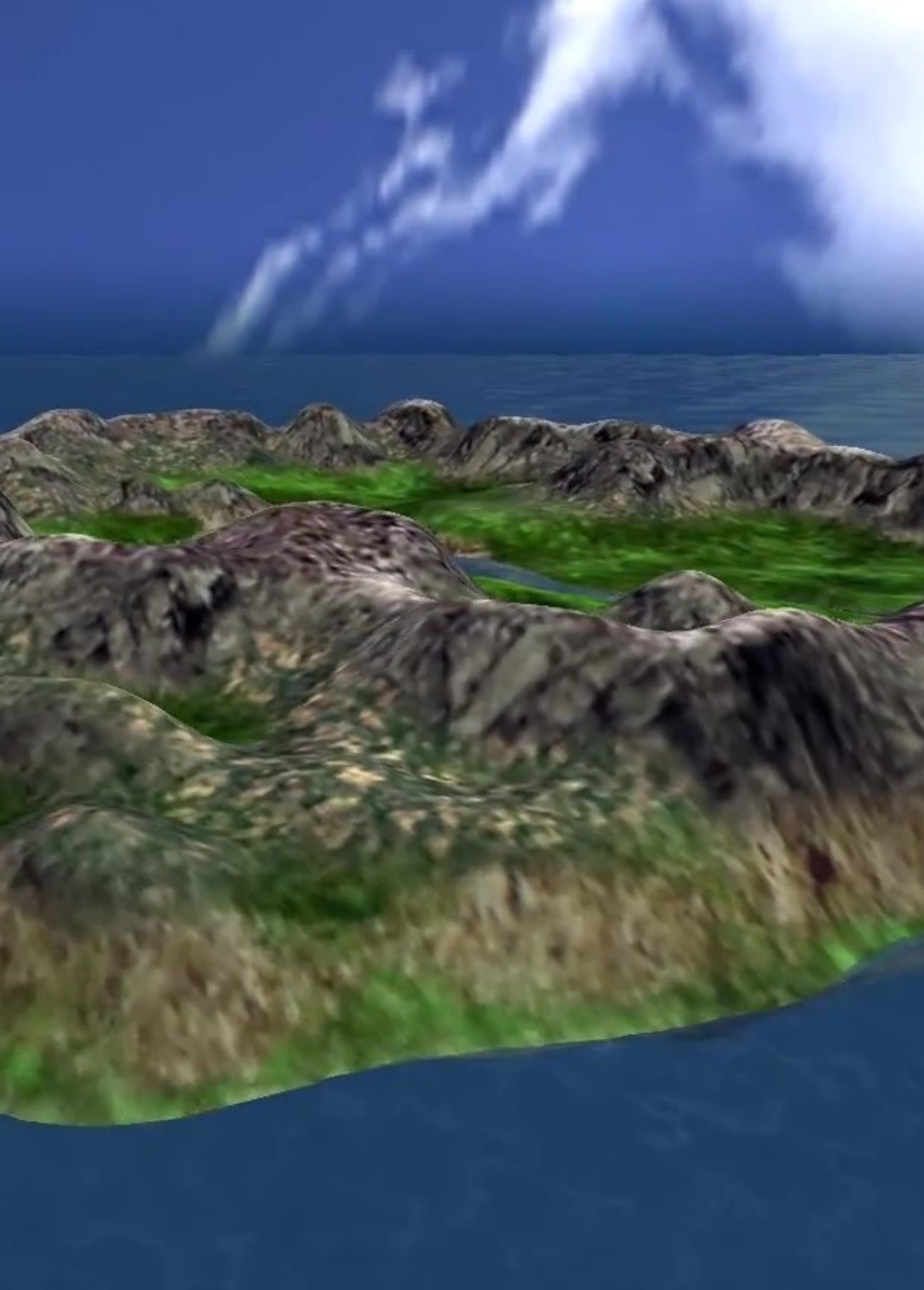
**SUPER MARIO 64: SIMPLE DARK SHAPES
GROUND CHARACTERS**



**TERRAIN ENGINE: TEXTURE SPACE IS READY
FOR PAINTED LIGHTING**



- Old games often put shadows into textures or decals instead of computing them every frame.
- For my terrain, the next natural step would be a baked light/shadow texture multiplied with the terrain color.
- The same principle already appears in my project: terrain detail is carried by images, not extra geometry.



WHAT I WOULD IMPROVE NEXT

- Terrain chunks and frustum culling instead of one whole grid.
- Distance-based LOD or geometry clipmaps.
- Render reflection into a texture from a mirrored camera, then sample it on water.
- Baked light/shadow texture for static cliffs and terrain.
- More realistic water normals from normal maps or Gerstner waves.



THANKS!

DO YOU HAVE ANY QUESTIONS?