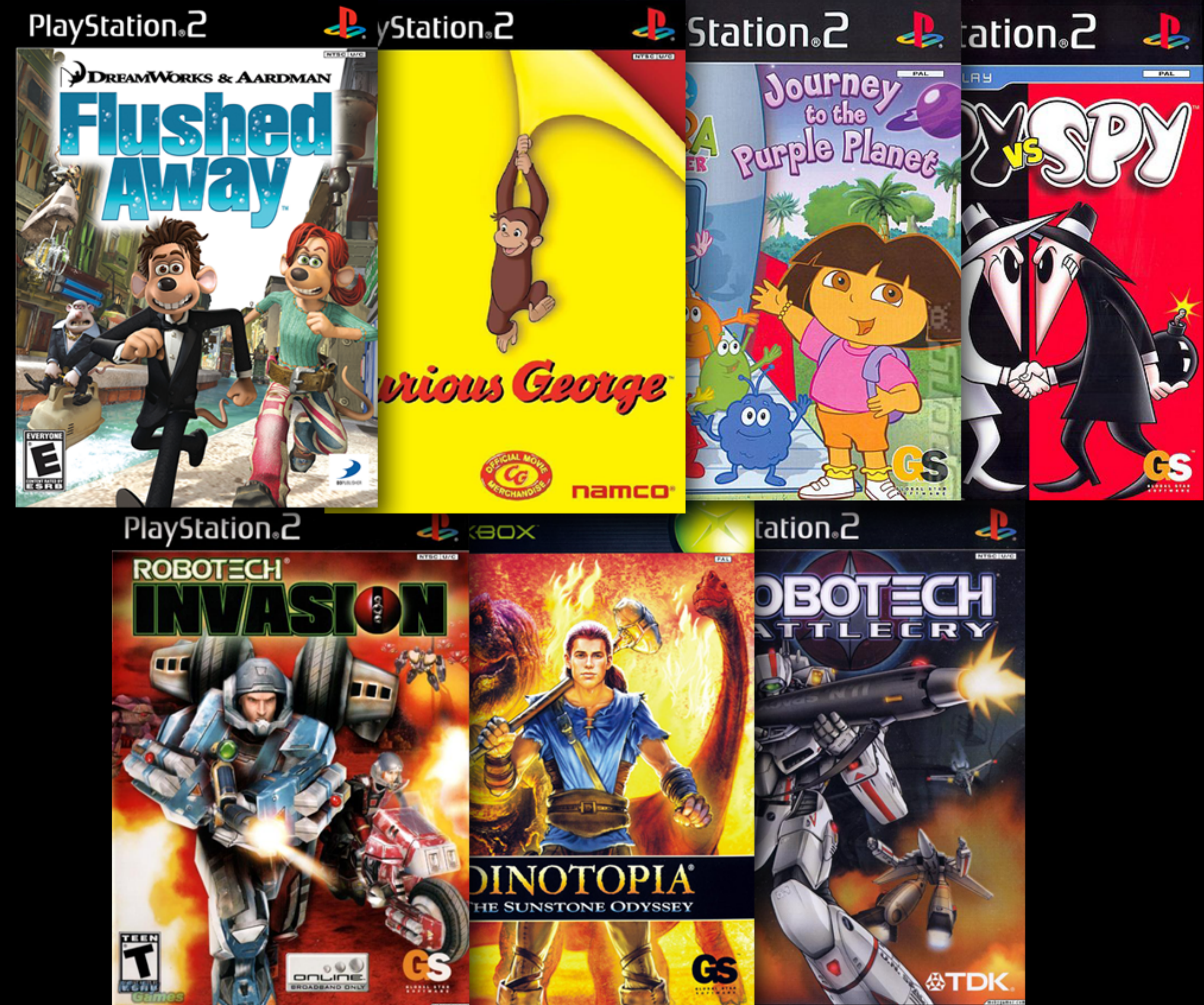
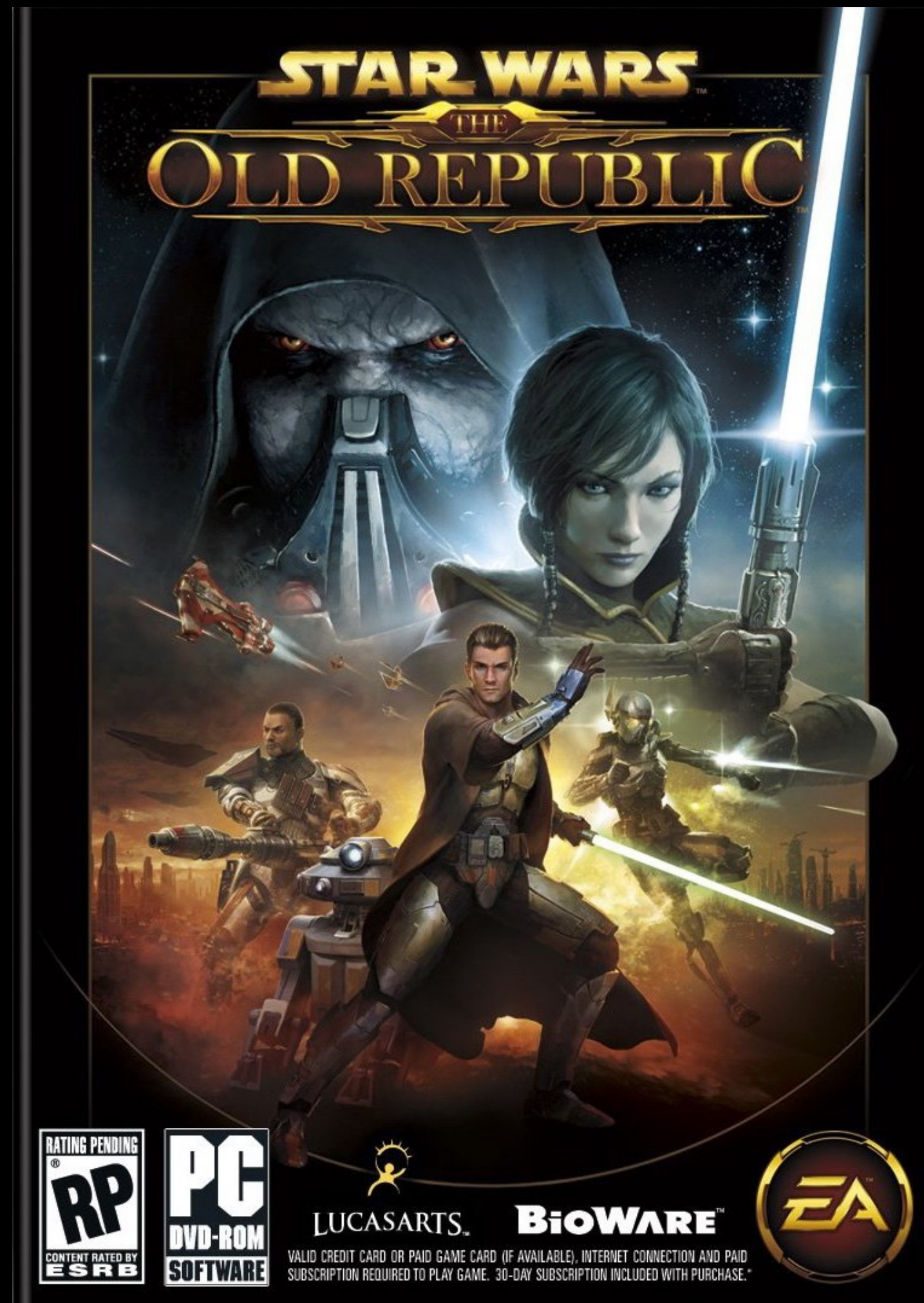


Shaders 101

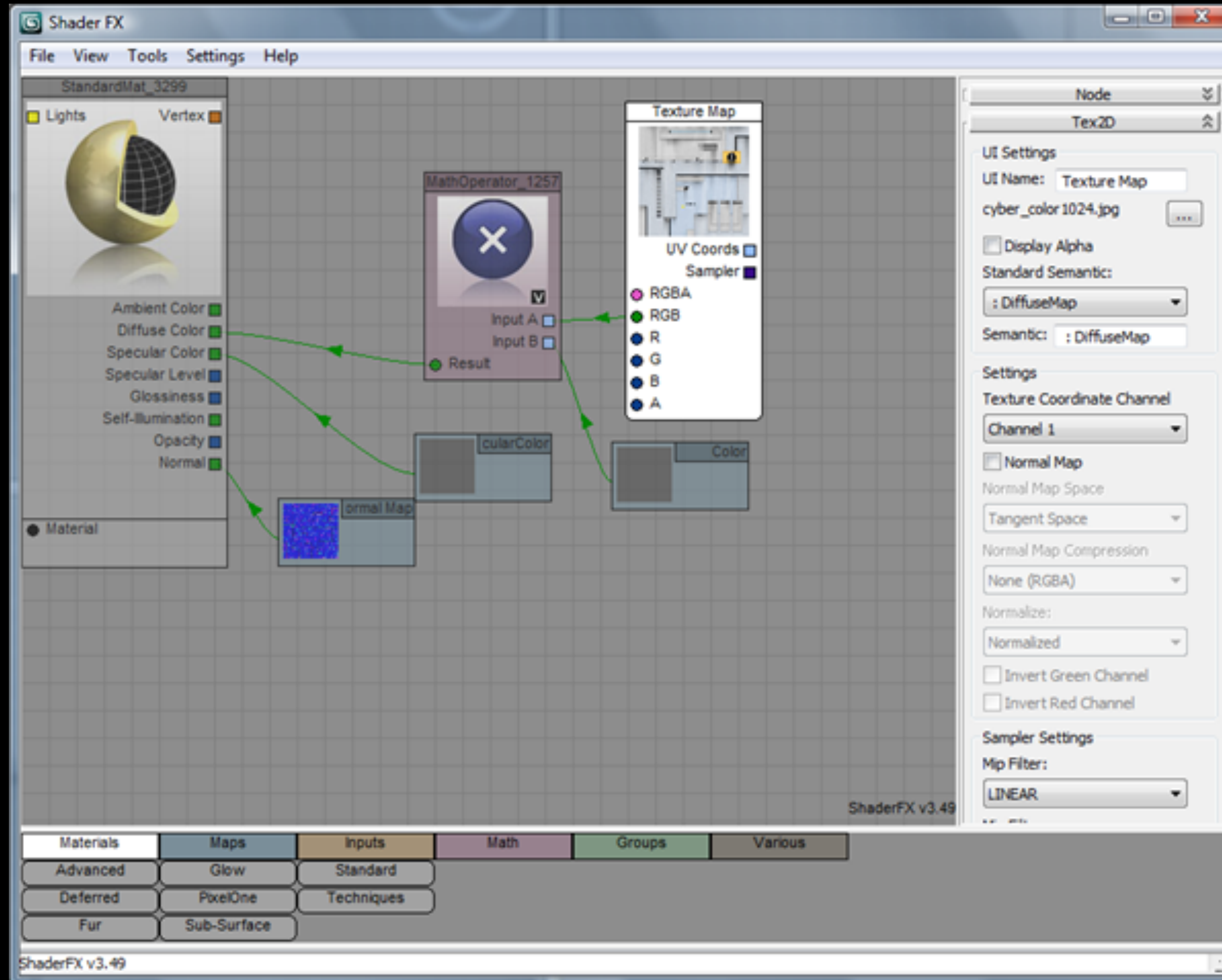
Foundational Shader Concepts for Tech Artists

Ben Cloward
CG Supervisor
Bioware

Who Are You?



Who Are You?



Our Goal

- Basic shader concepts
- Distortion Example
- Atlas Walk Example
- Environment Blend Example

These concepts can be used in shader code and in node-based editors

Basic Shader Concepts

- What is a shader?
- What can a shader do?
- Data Types

What Is A Shader

- Code that controls the color of each pixel on the screen
- Usually runs on the graphics processor

Shaders Today

- Game engines using advanced PBR lighting and rendering
- Lighting model is more locked down
- Shaders now feed the G buffer - color, normal, roughness, metallic
- Most engines have a built-in shader editor
- Shaders control material properties

Shaders Can Do Lots of Things

- Base Color
- Reflectance
- Surface Normal
- Ambient Occlusion
- Diffuse Light
- Shadows
- Metallicity
- Ambient Light
- Roughness
- Light Reflections
- Environment Reflections

Shaders Can Do Lots of Things

Surface Properties

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Shaders Can Do Lots of Things

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- Roughness

Our shaders
will do
this stuff

Light Properties

- Diffuse Light
- Light Reflections
- Shadows
- Ambient Occlusion
- Environment Reflections
- Ambient Light

Data Types

float

- 1 value

float2

- 2 values
- UV coords

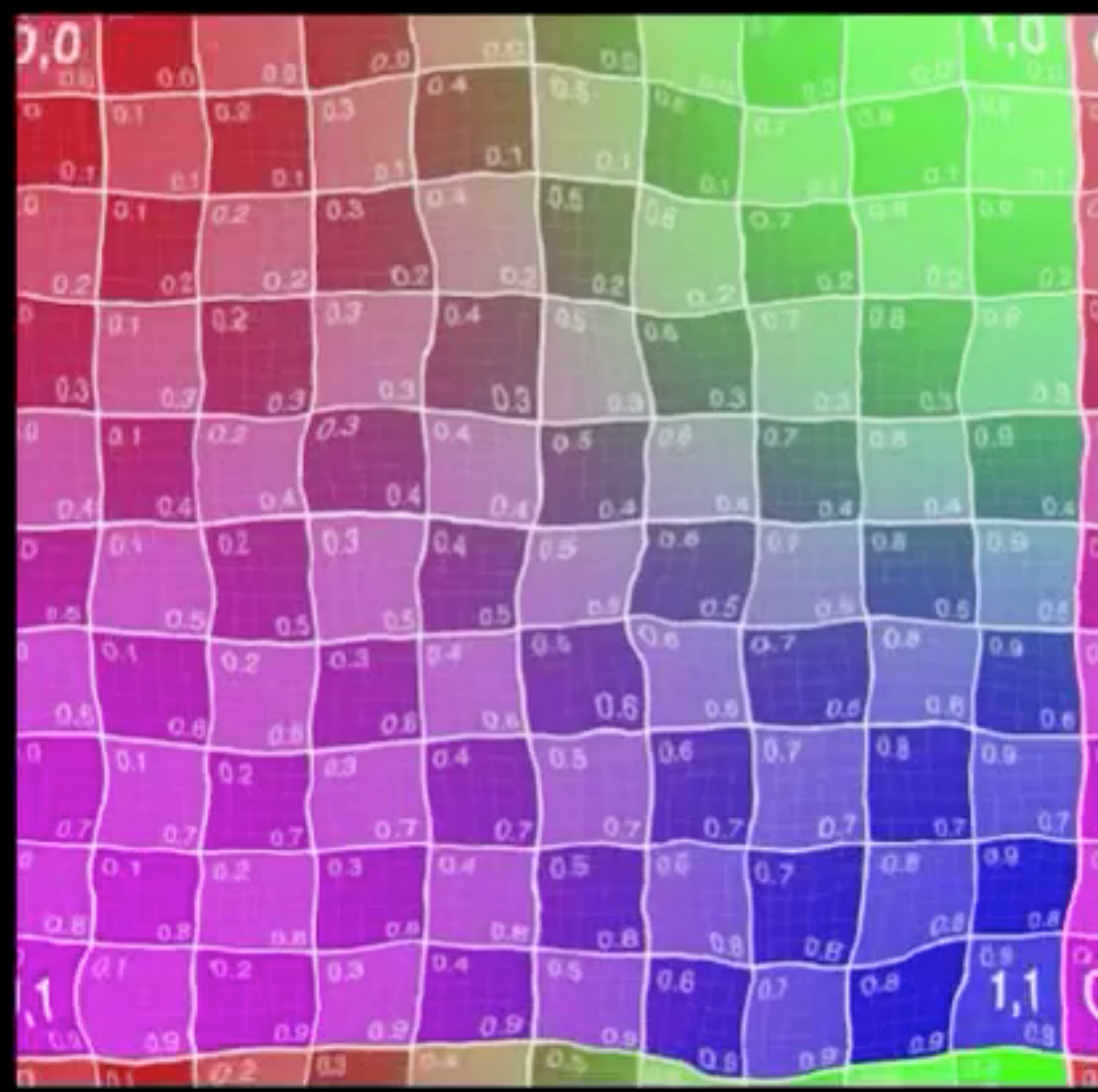
float3

- 3 values
- vectors
- colors

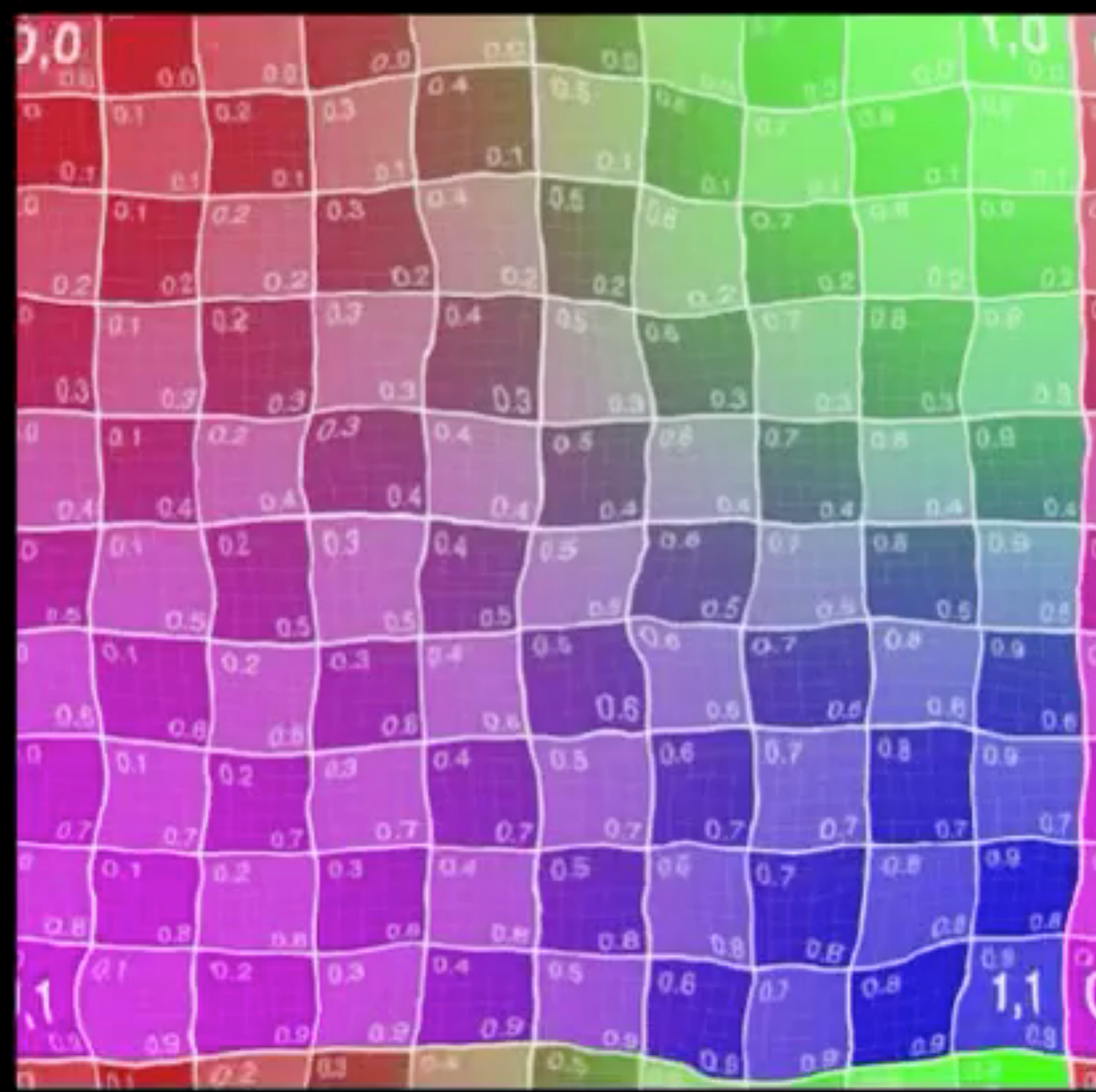
float4

- 4 values
- vectors with W
- colors with alpha

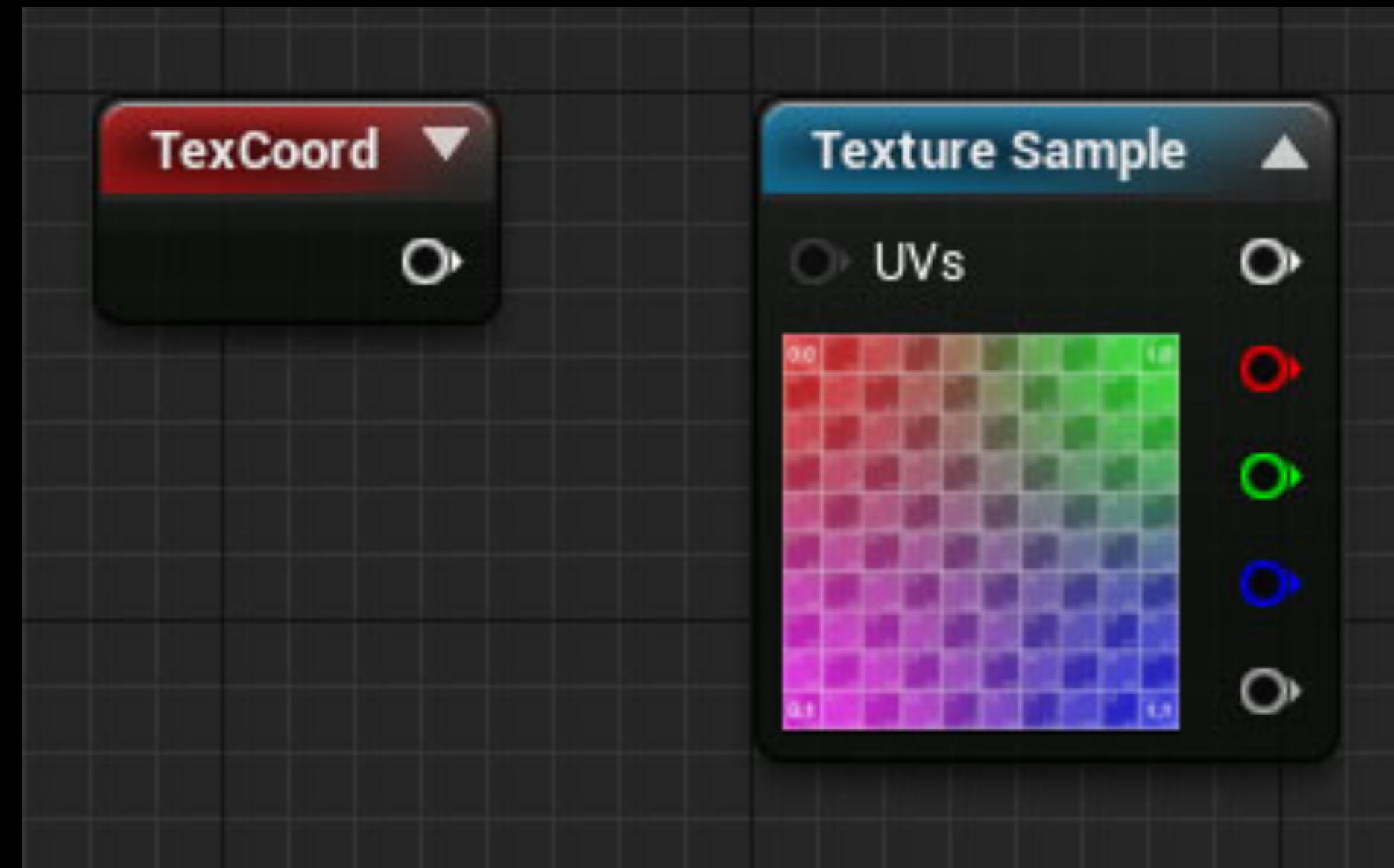
Distortion Example



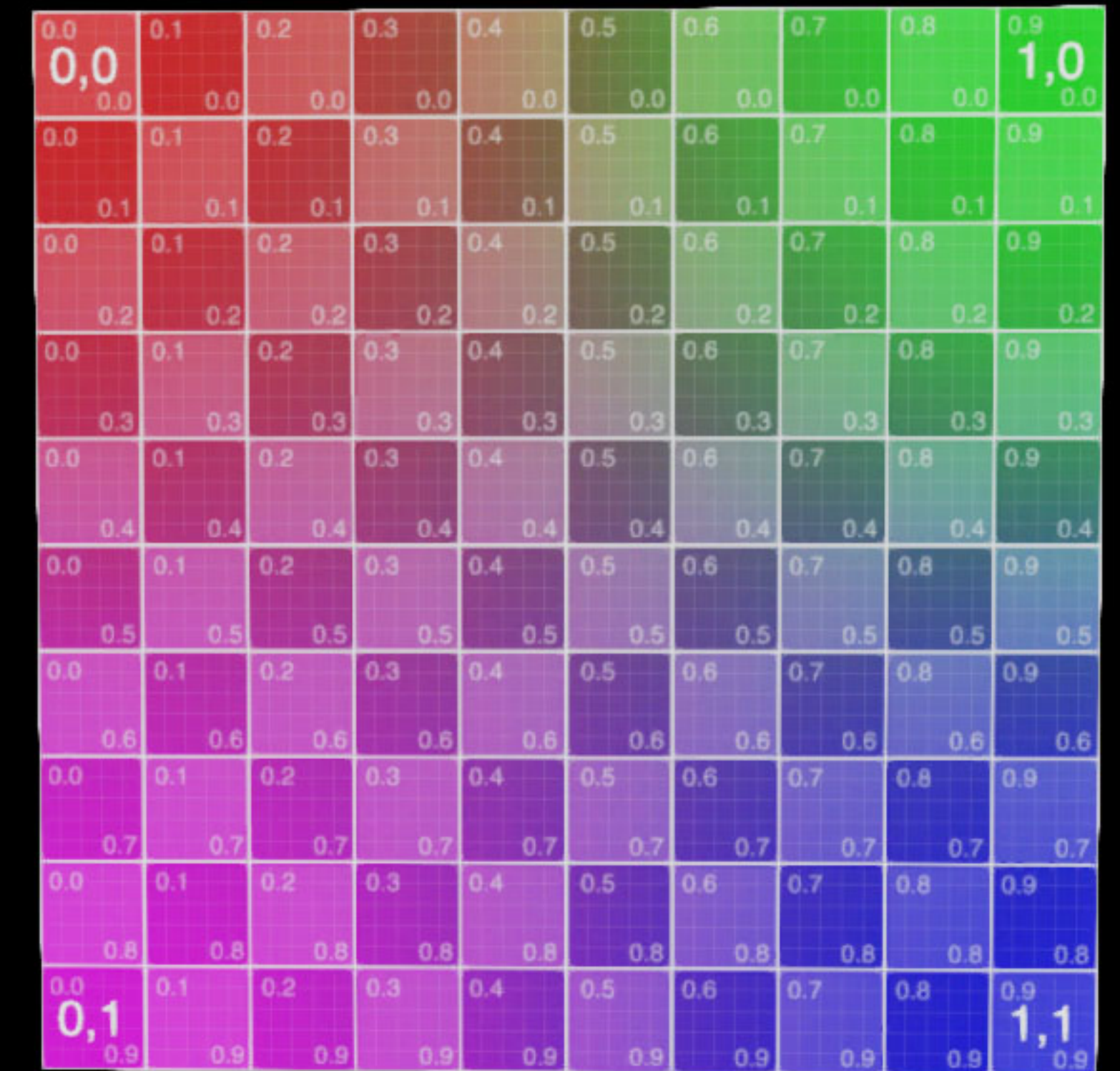
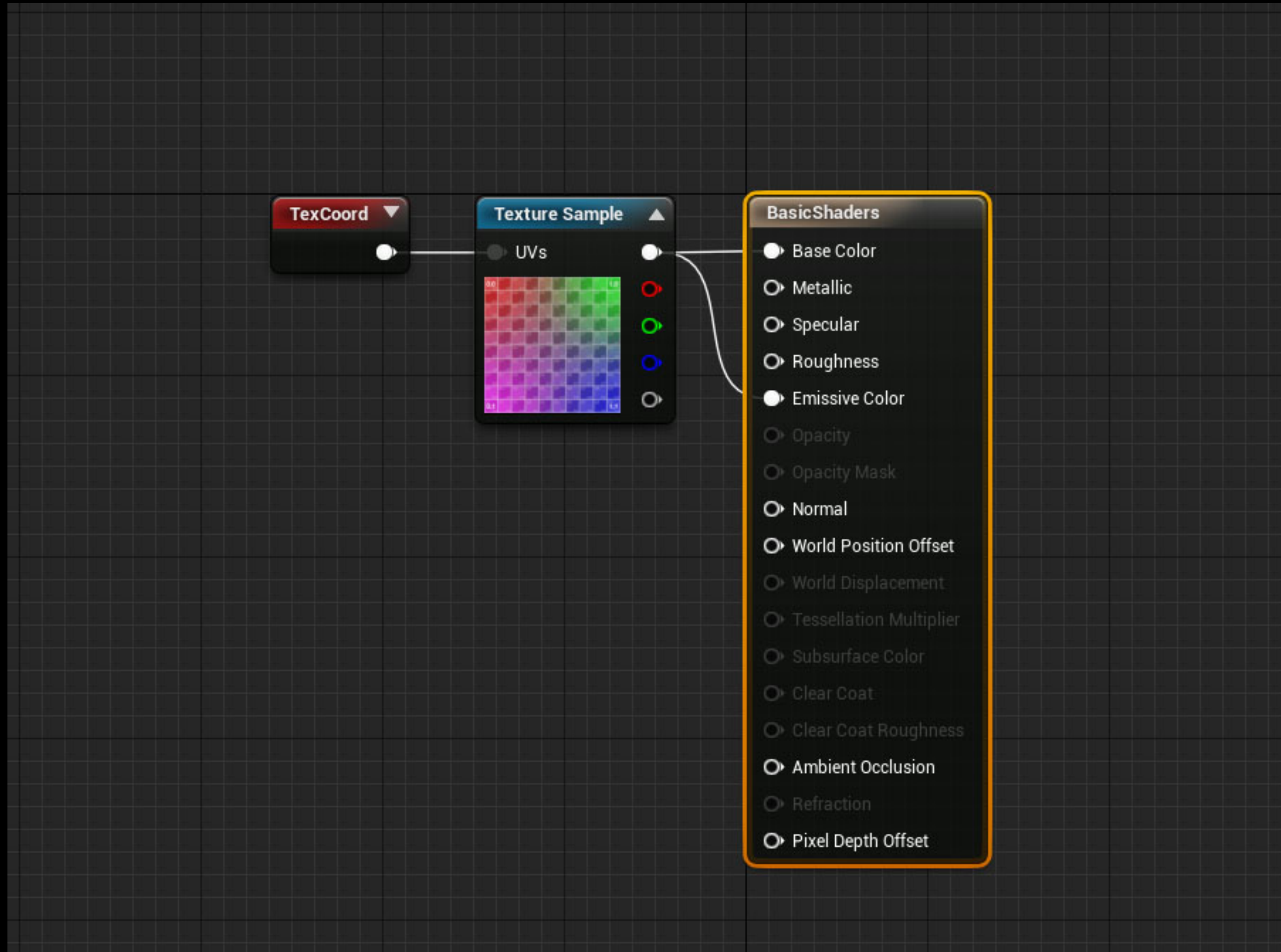
Distortion Example



Texture Map & UV Coordinates



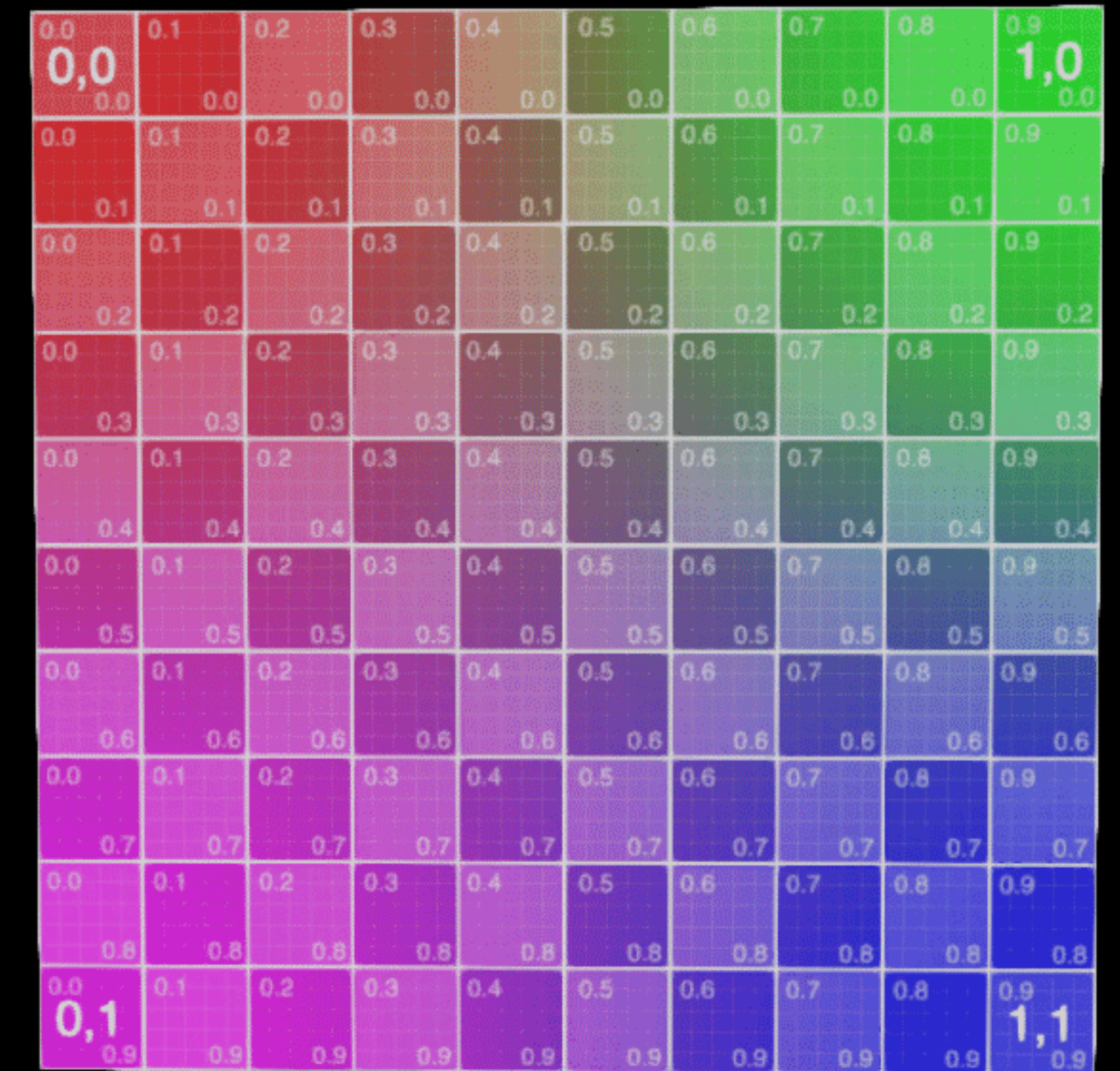
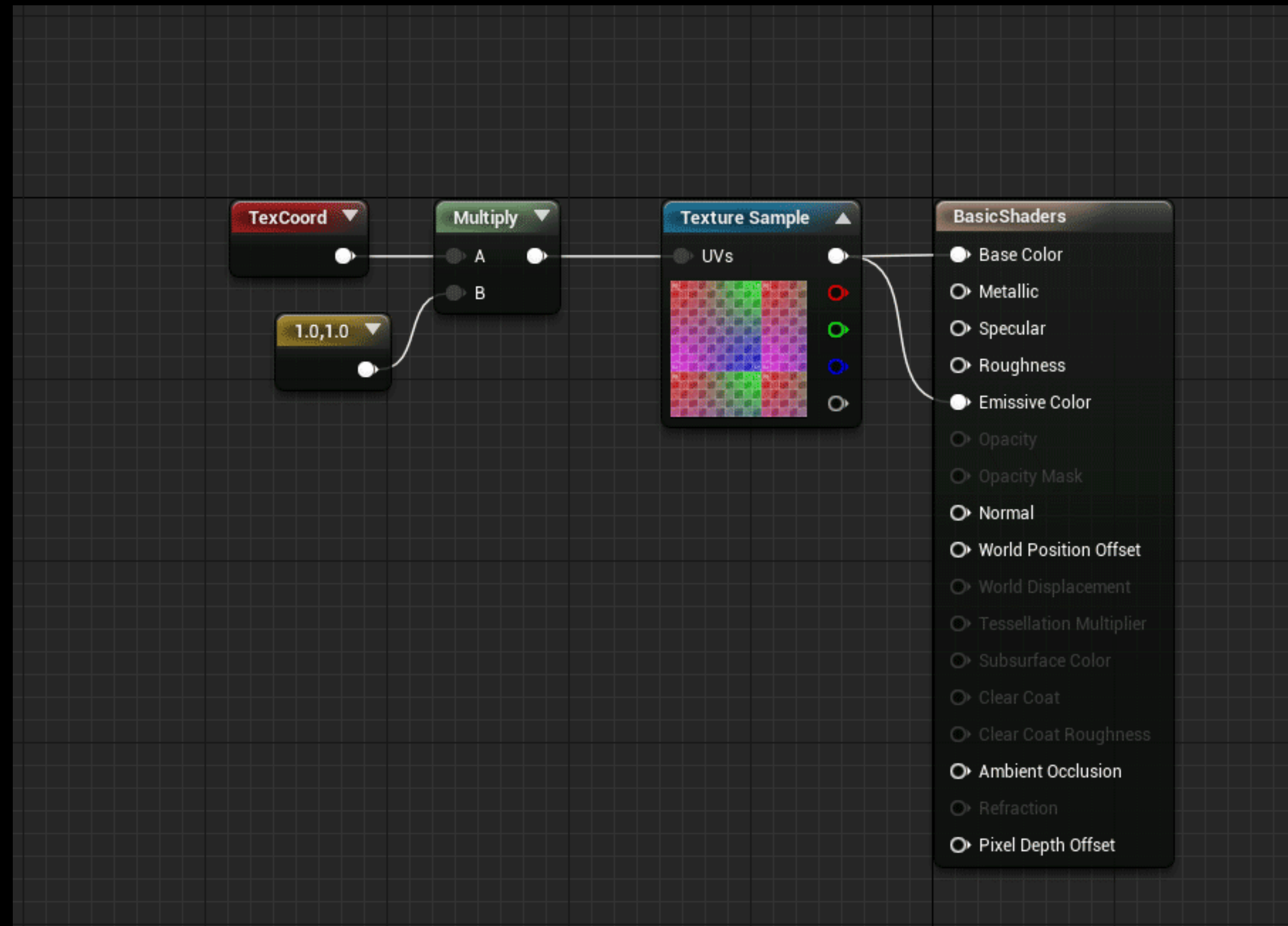
Basic Shader



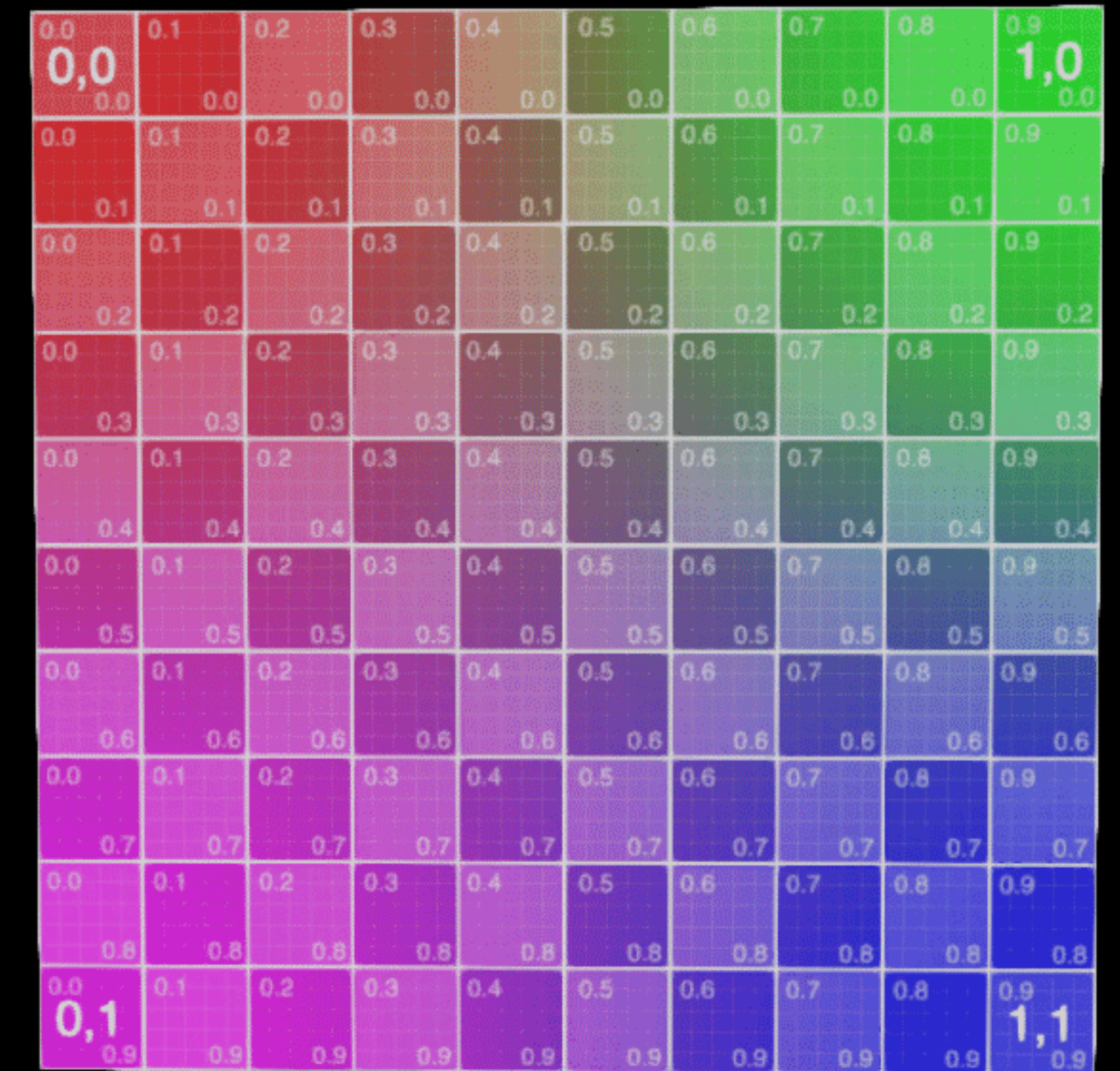
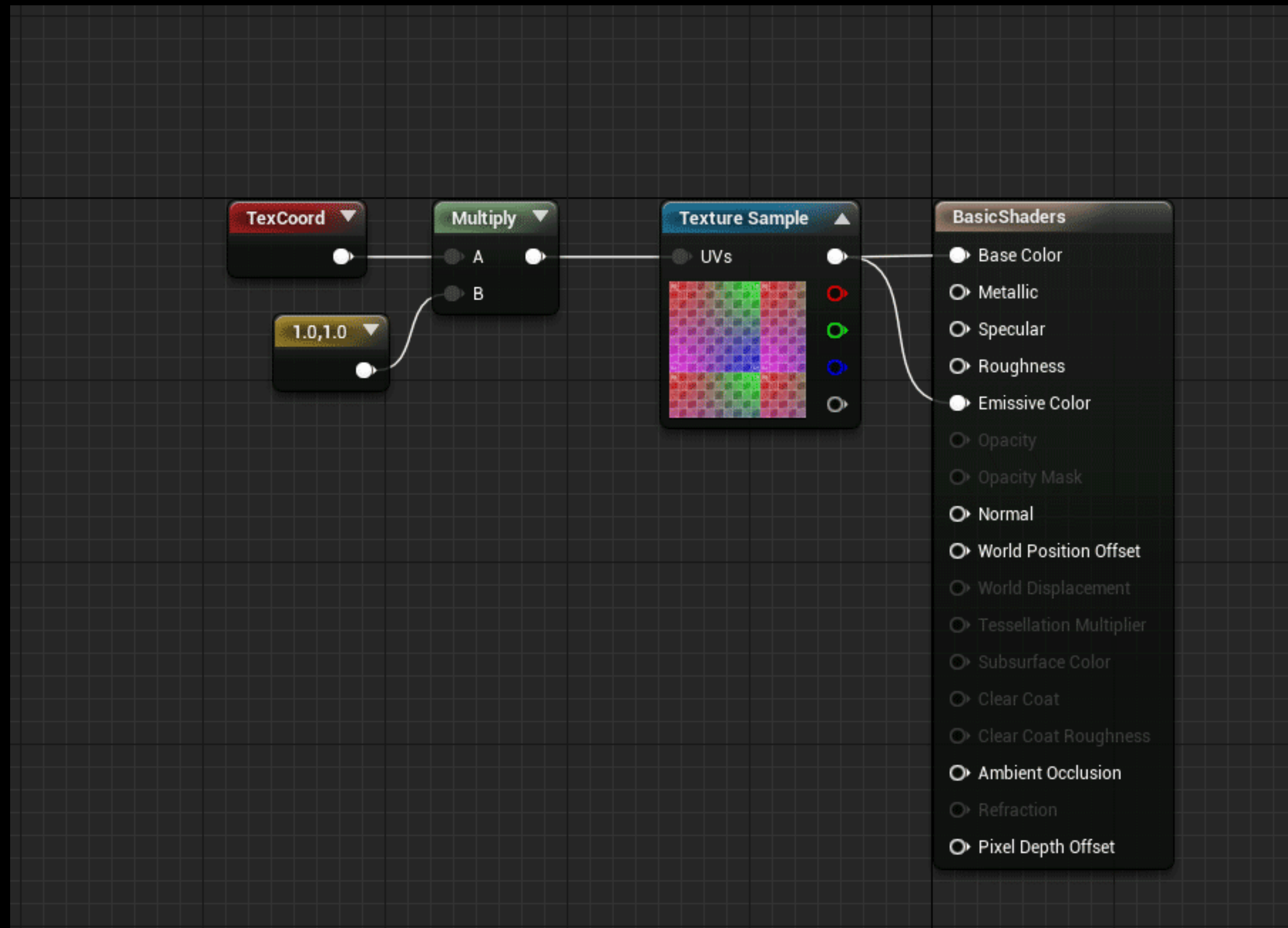
Multiply & Const. float2



Multiply Scales UV Coordinates



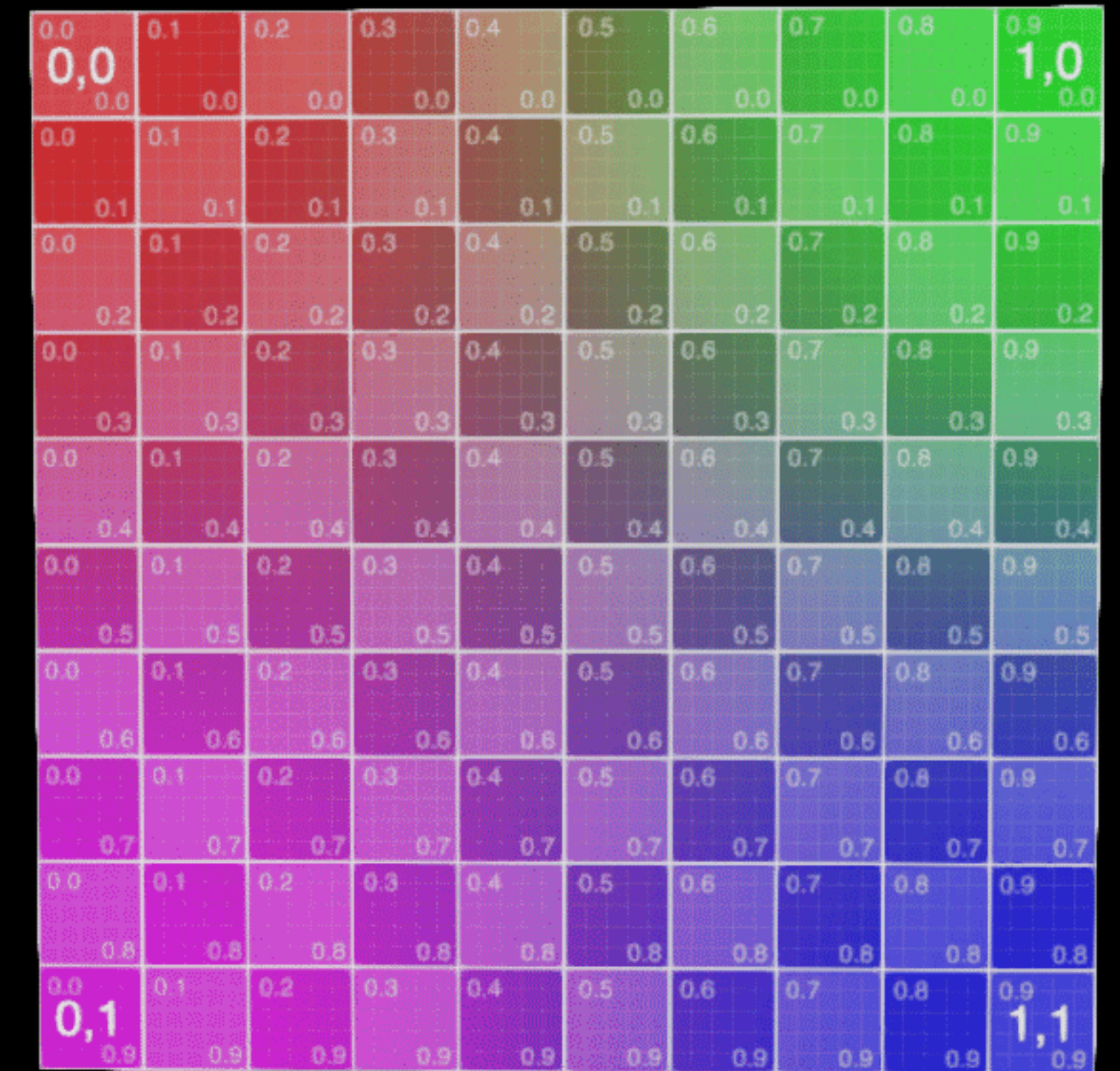
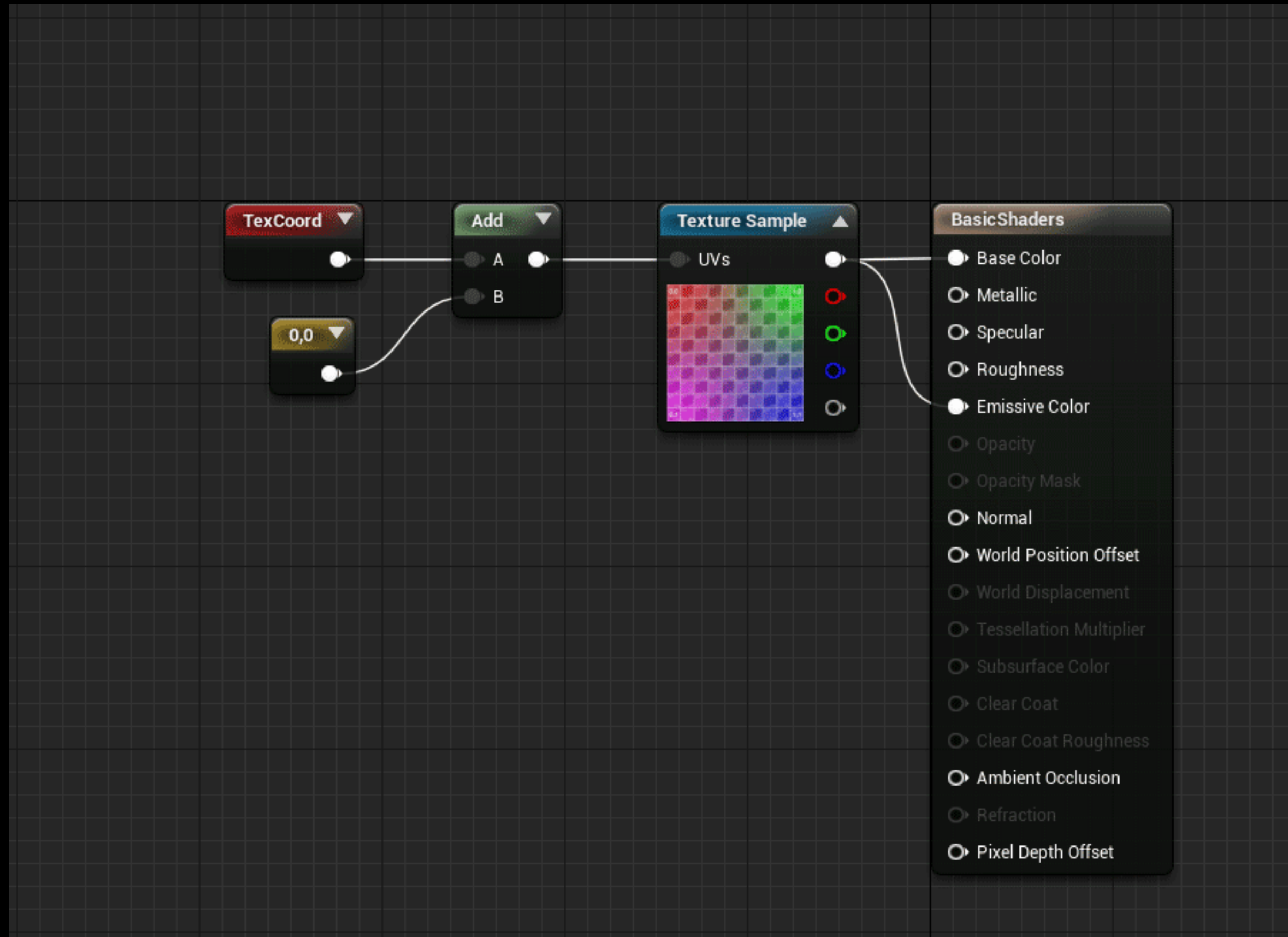
Multiply Scales UV Coordinates



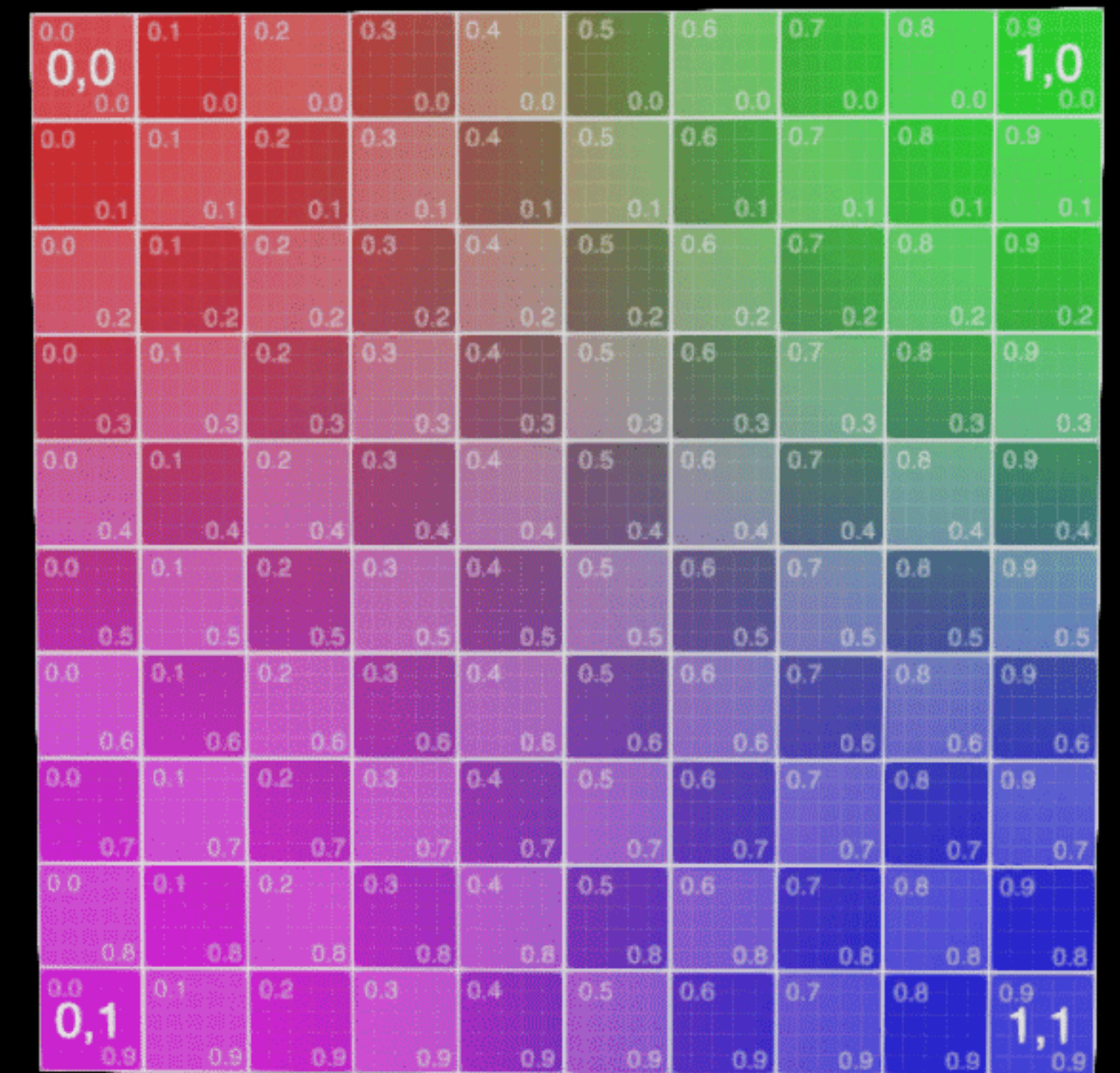
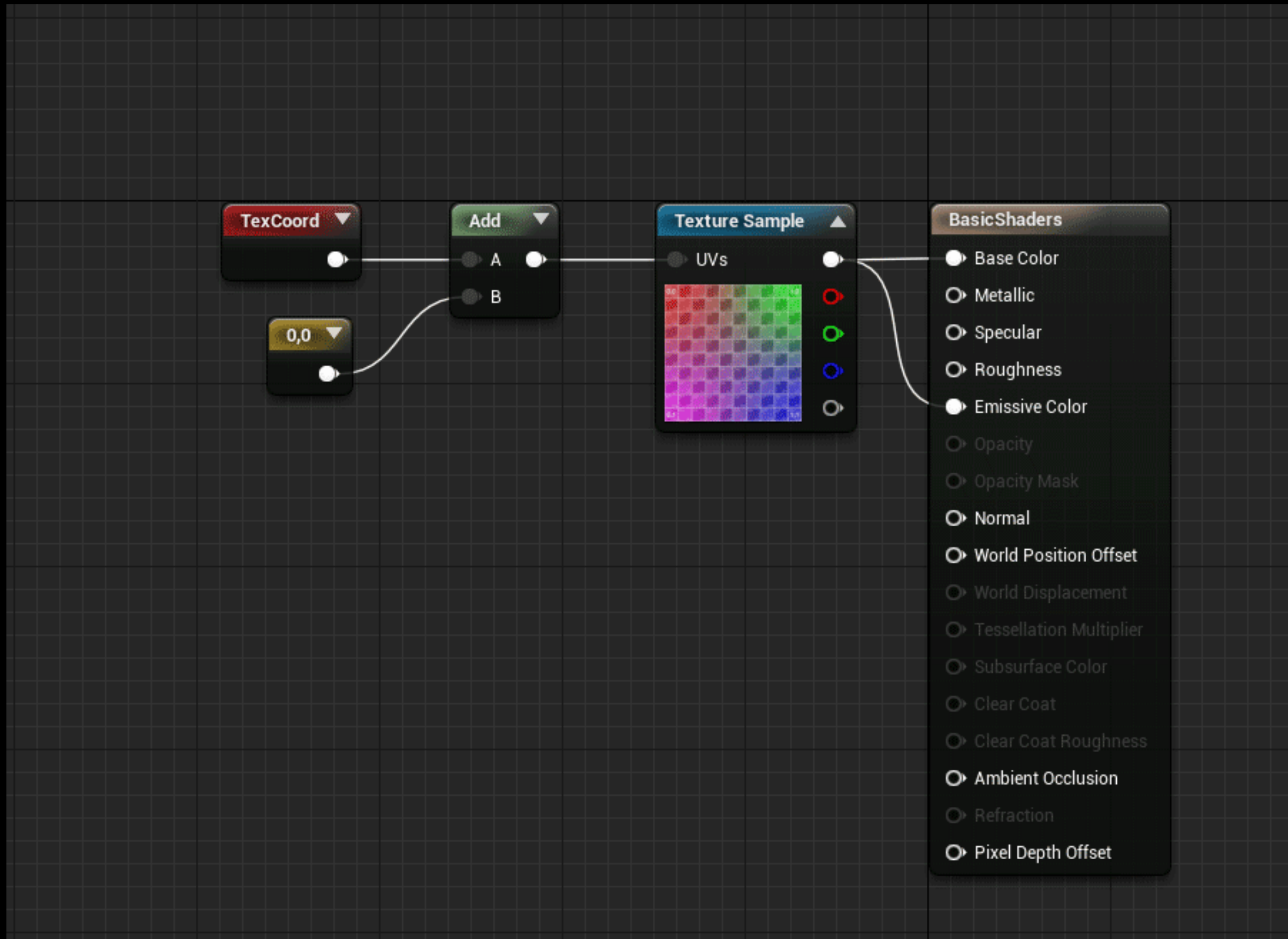
Add



Add Scrolls UV Coordinates



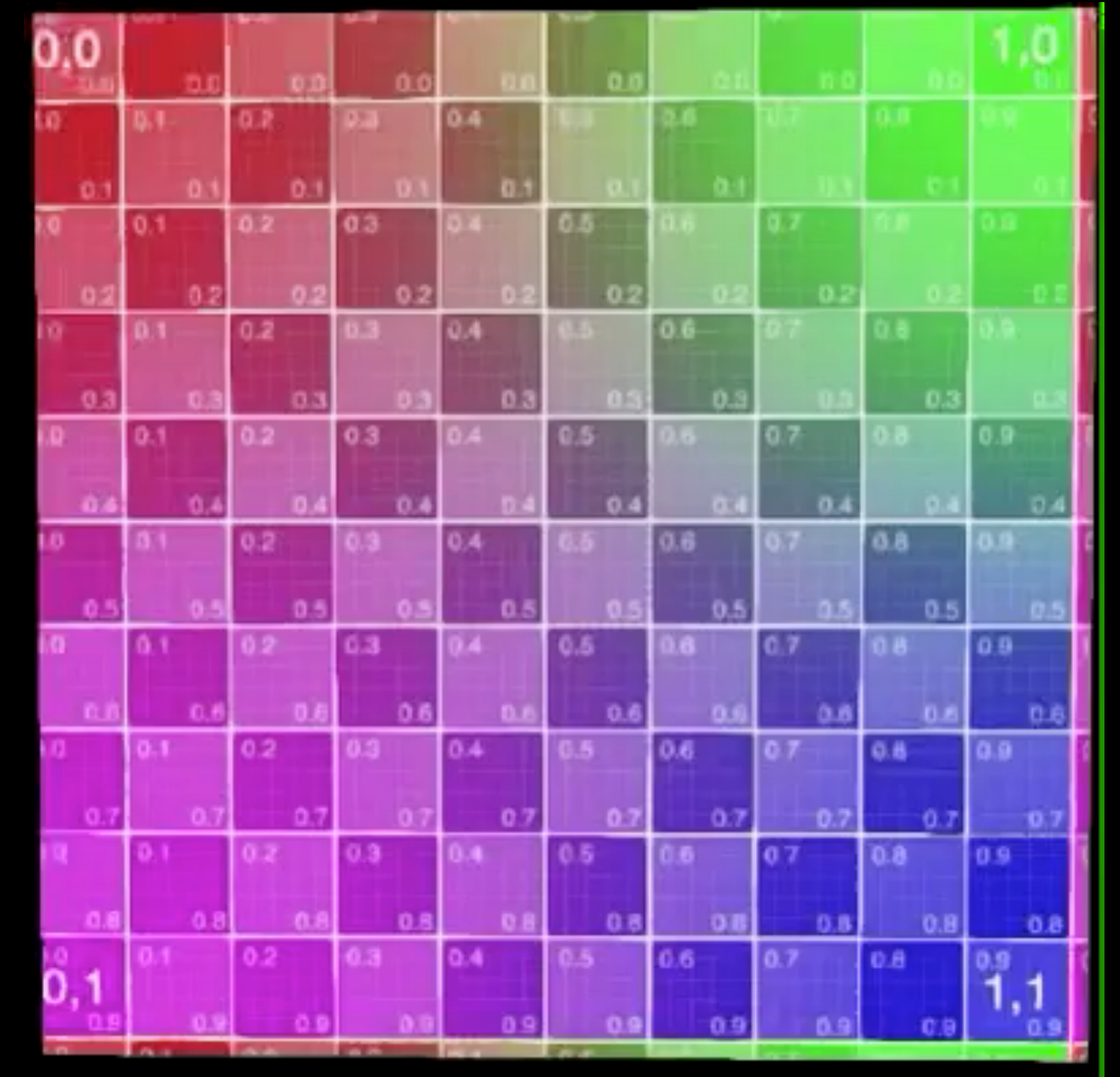
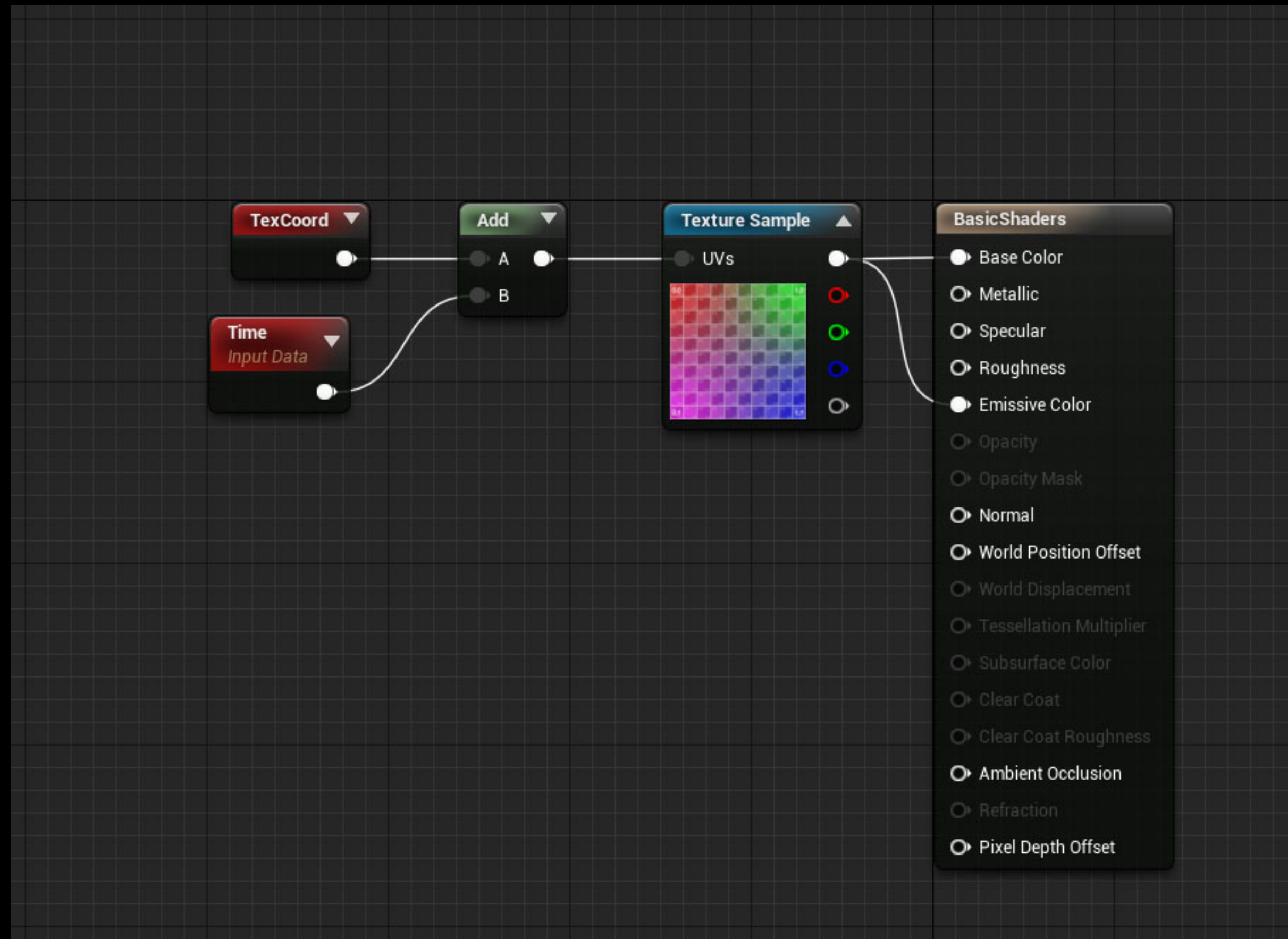
Add Scrolls UV Coordinates



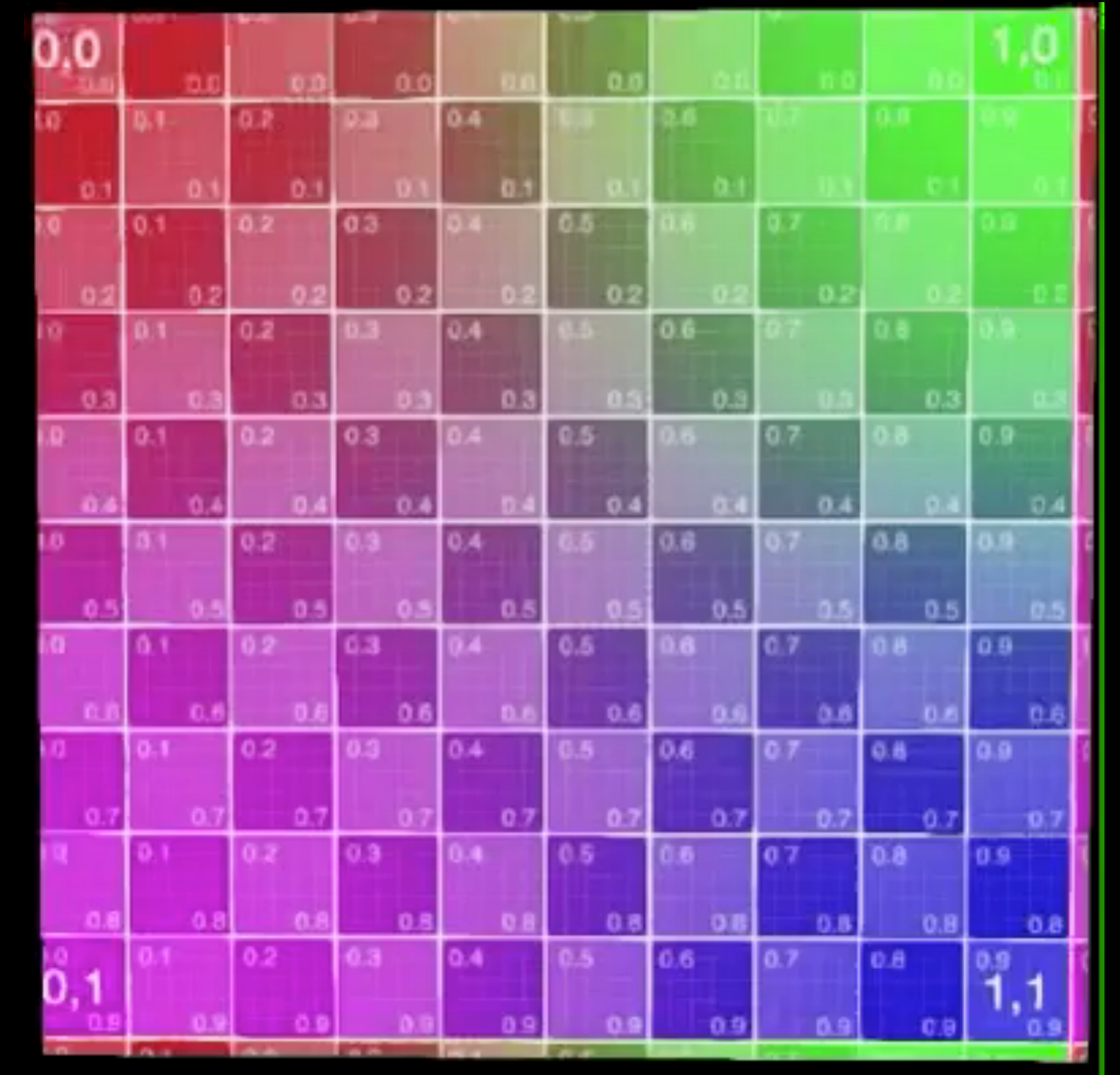
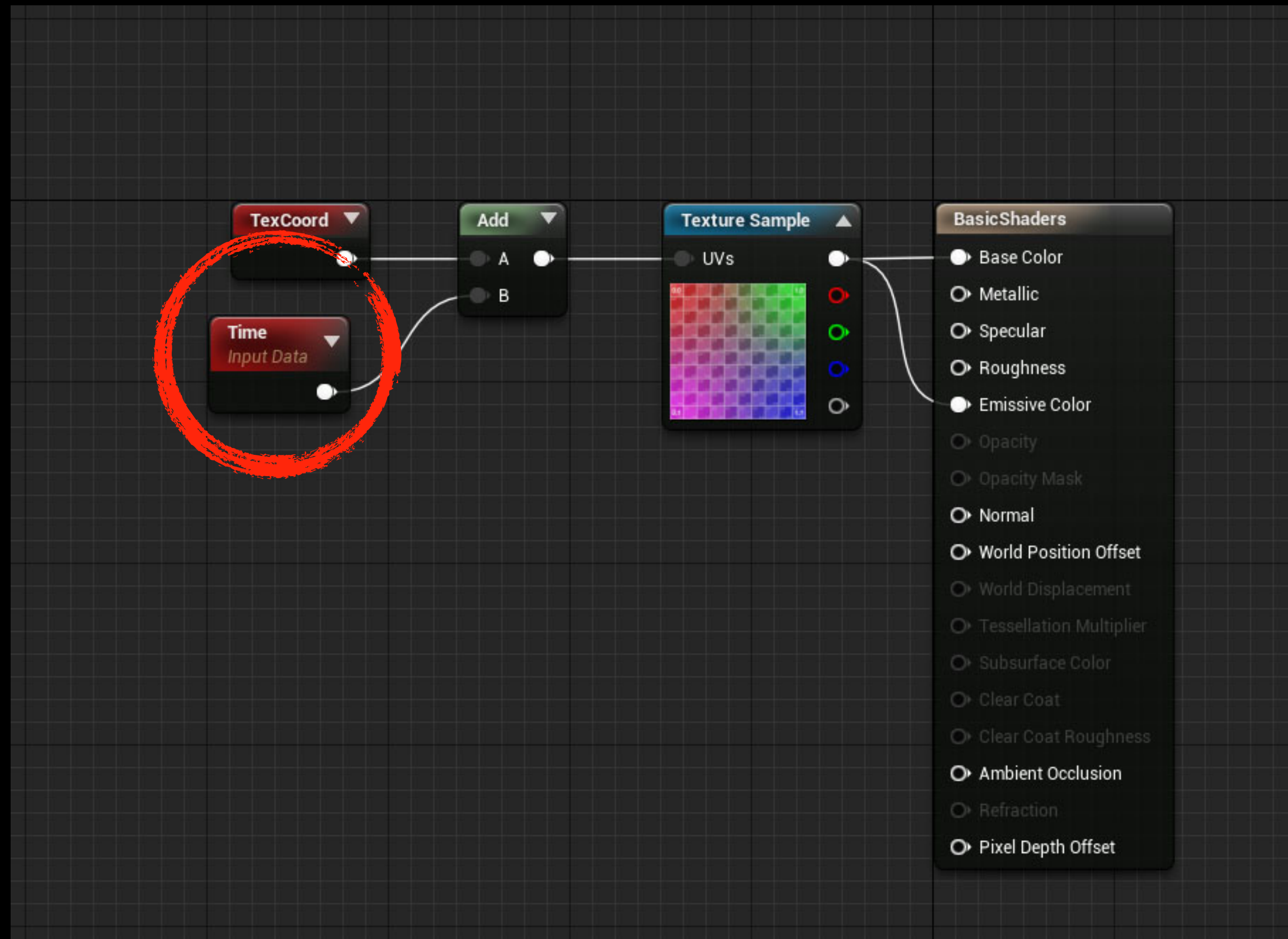
Time



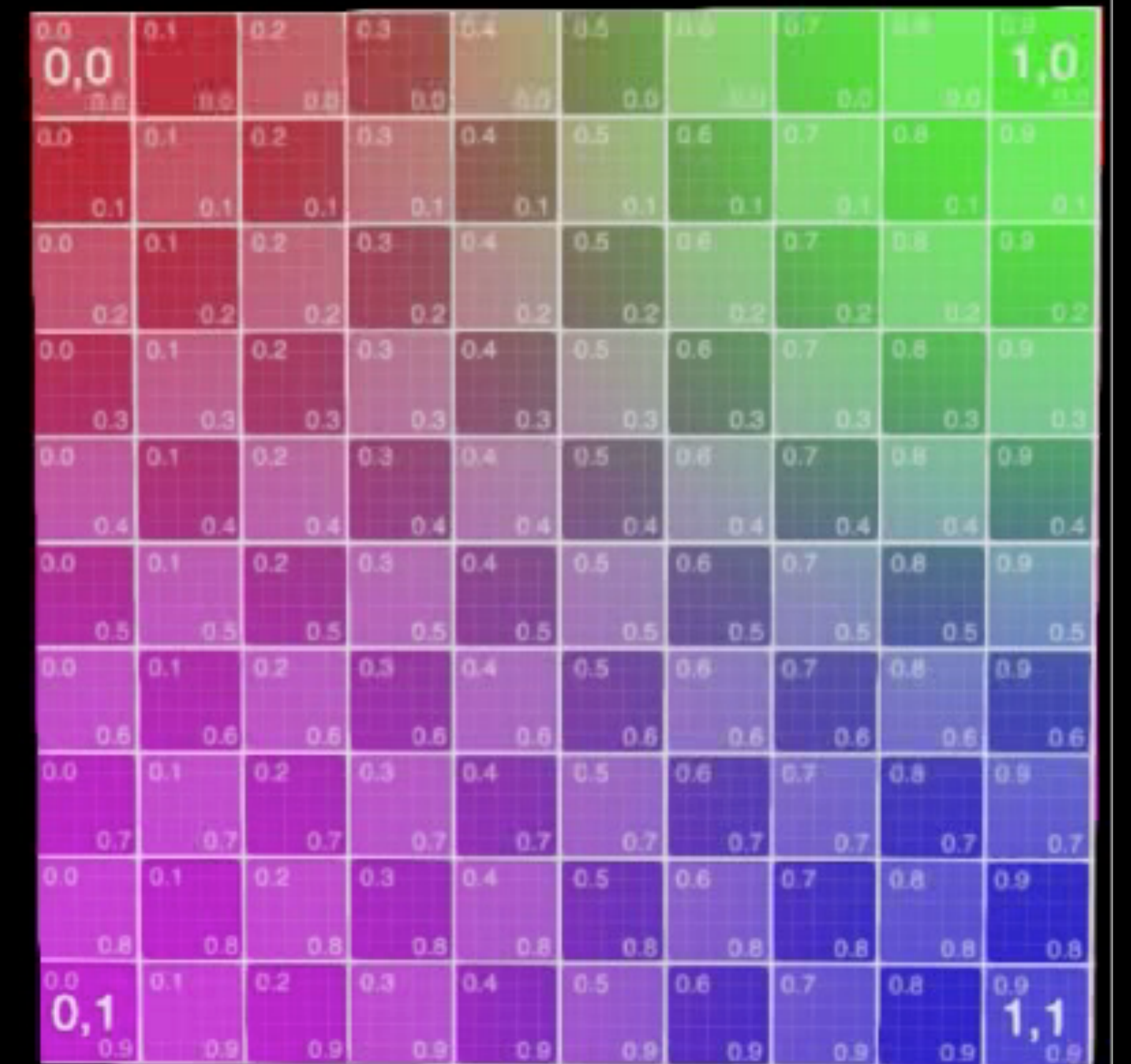
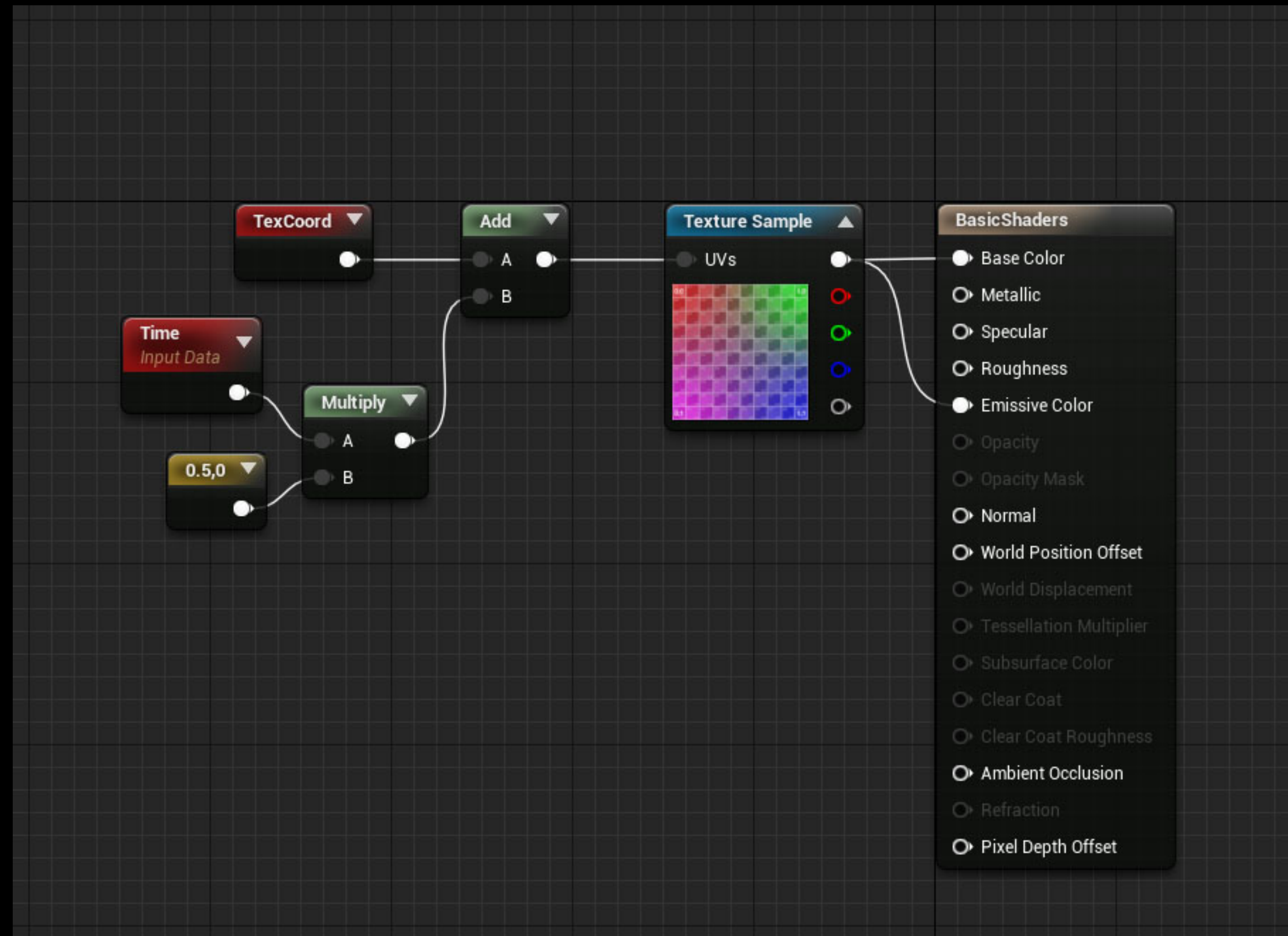
Use Time For Animation



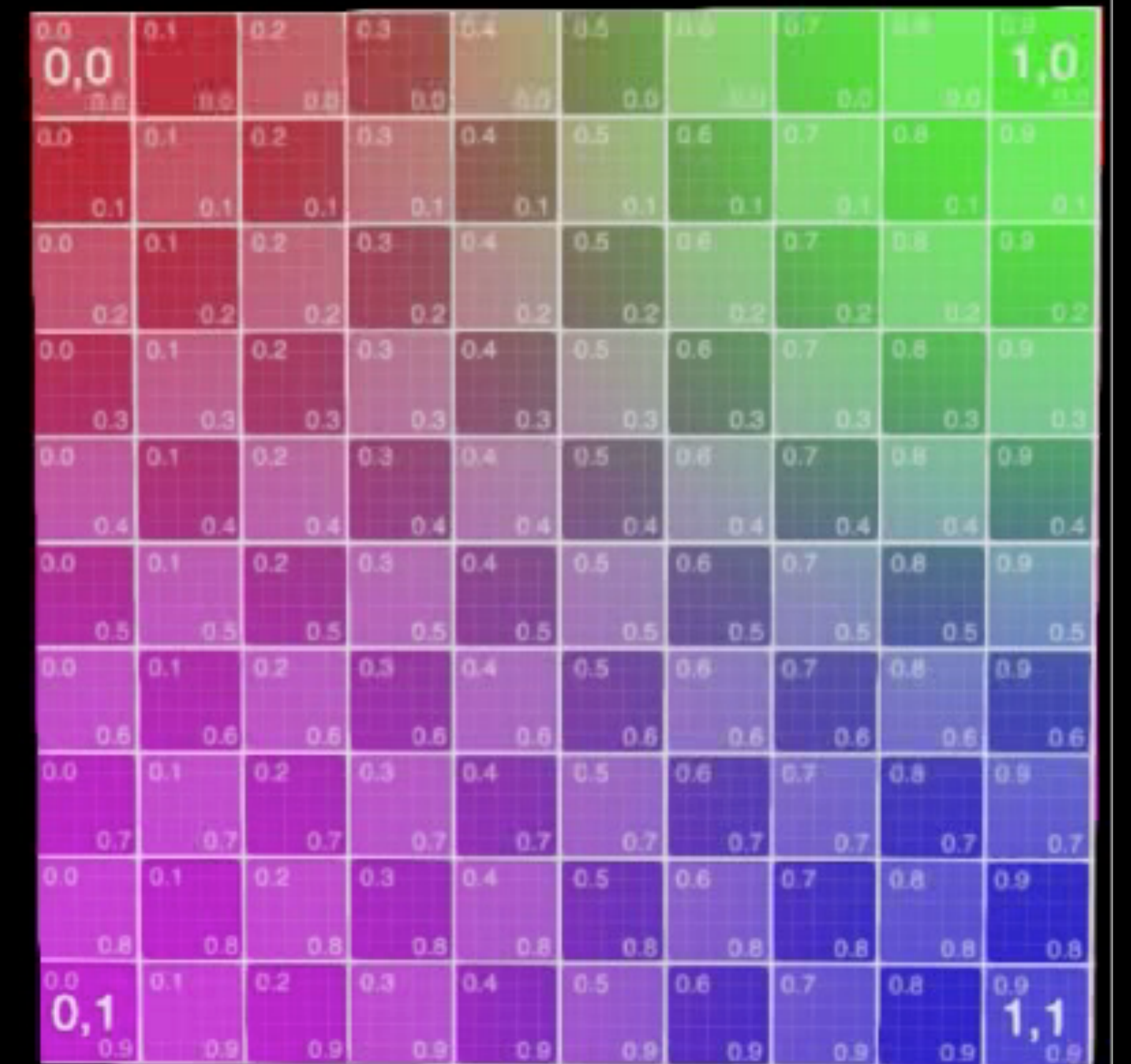
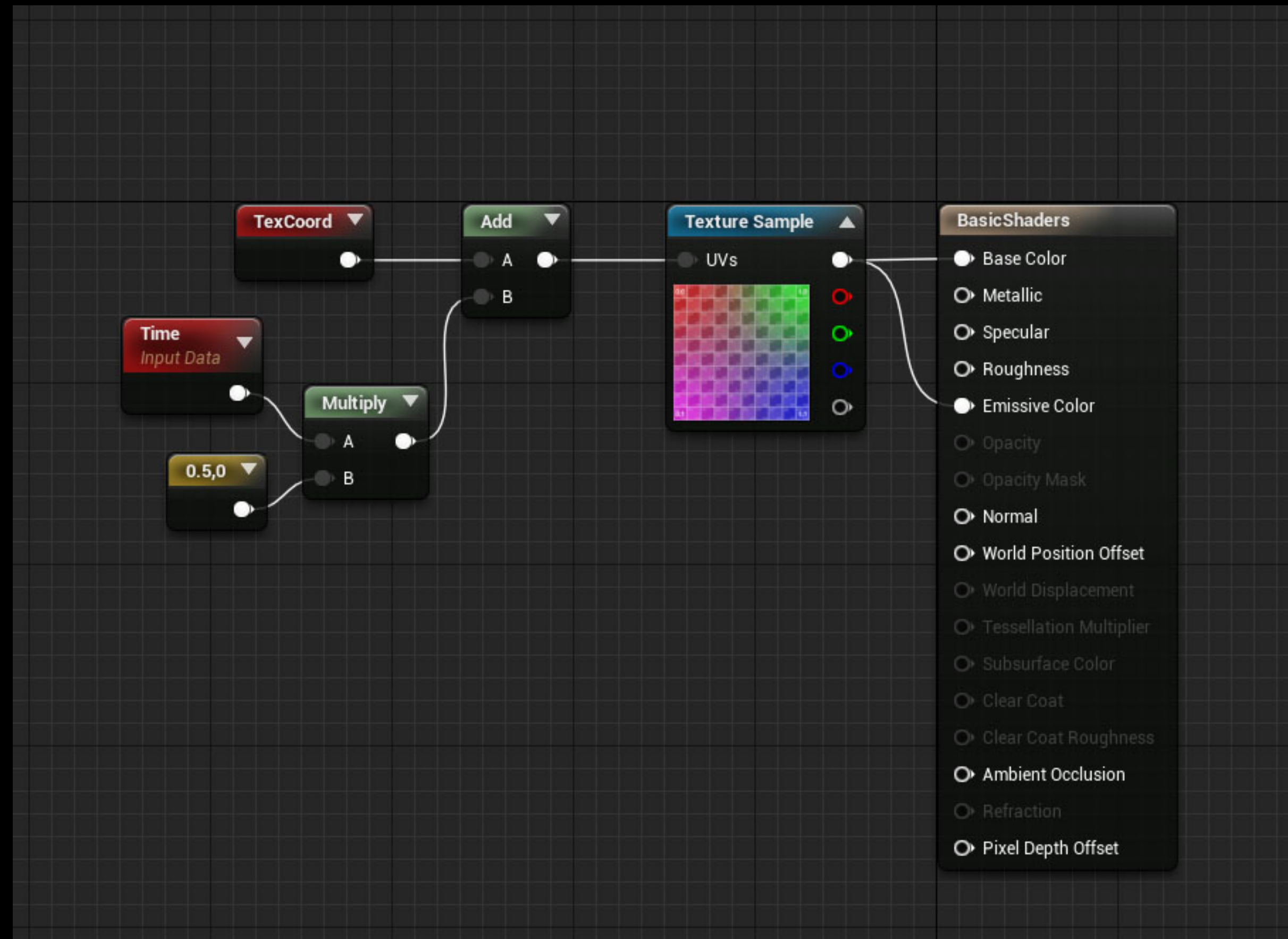
Use Time For Animation



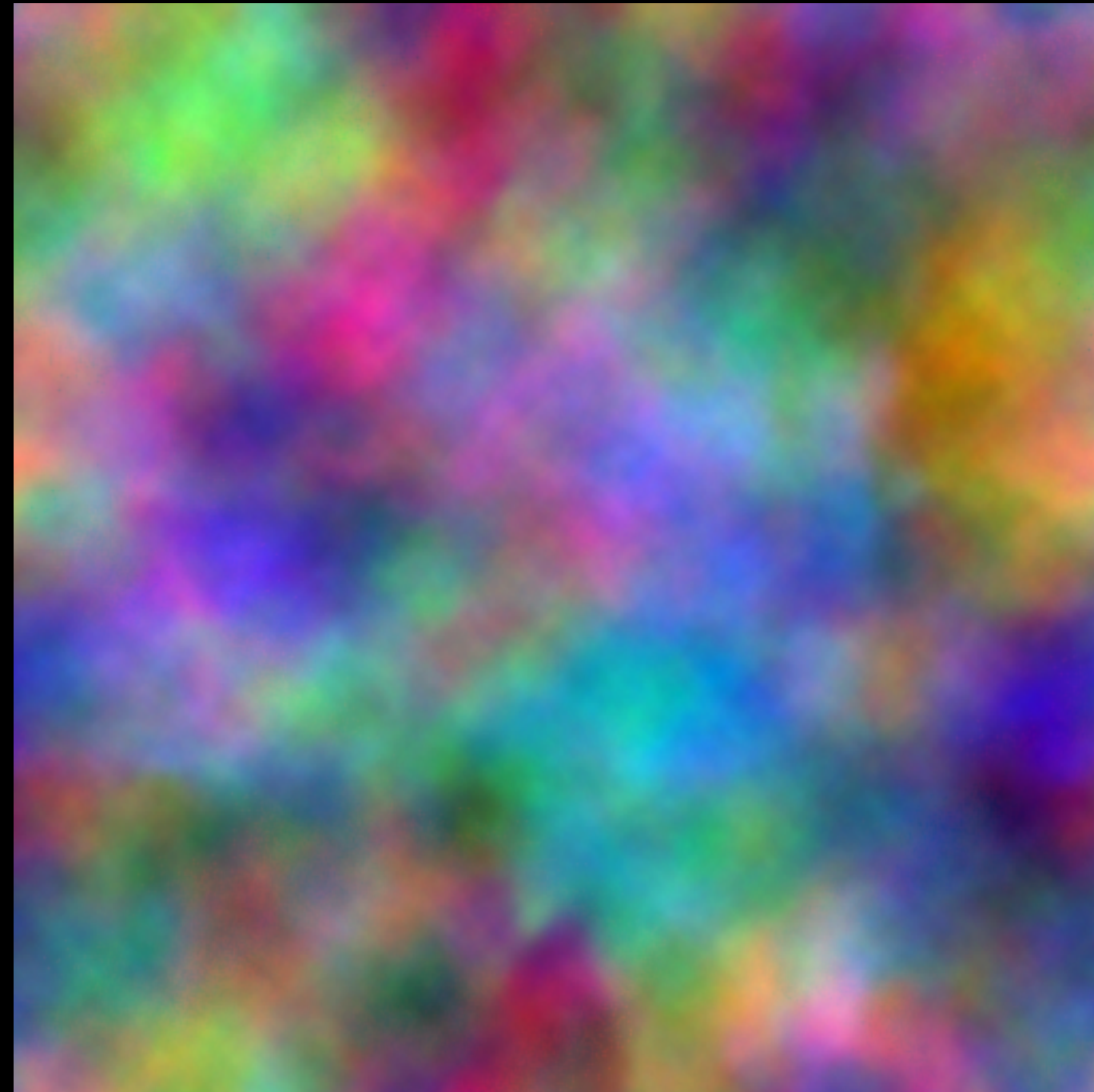
Control Speed With Multiply



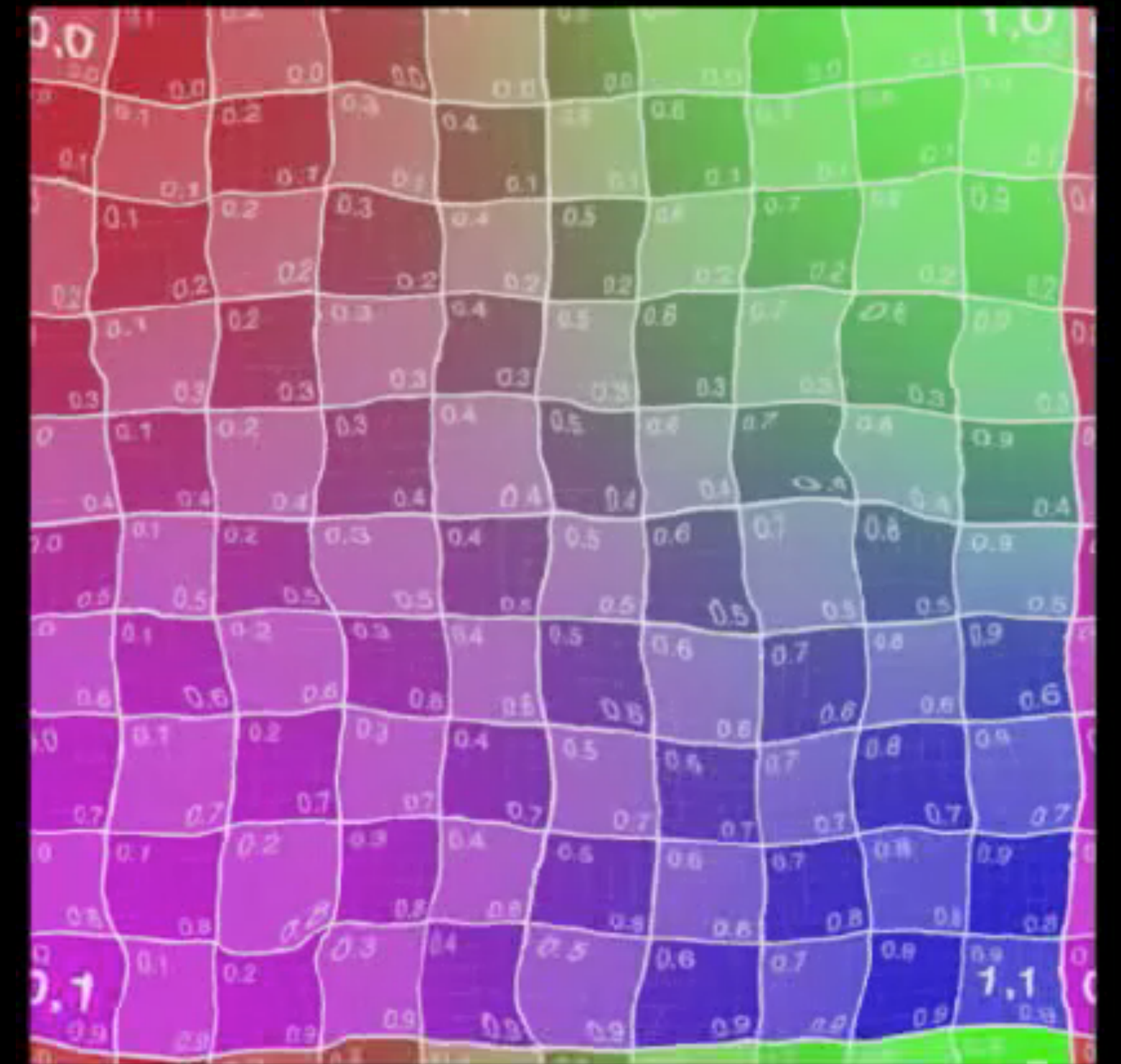
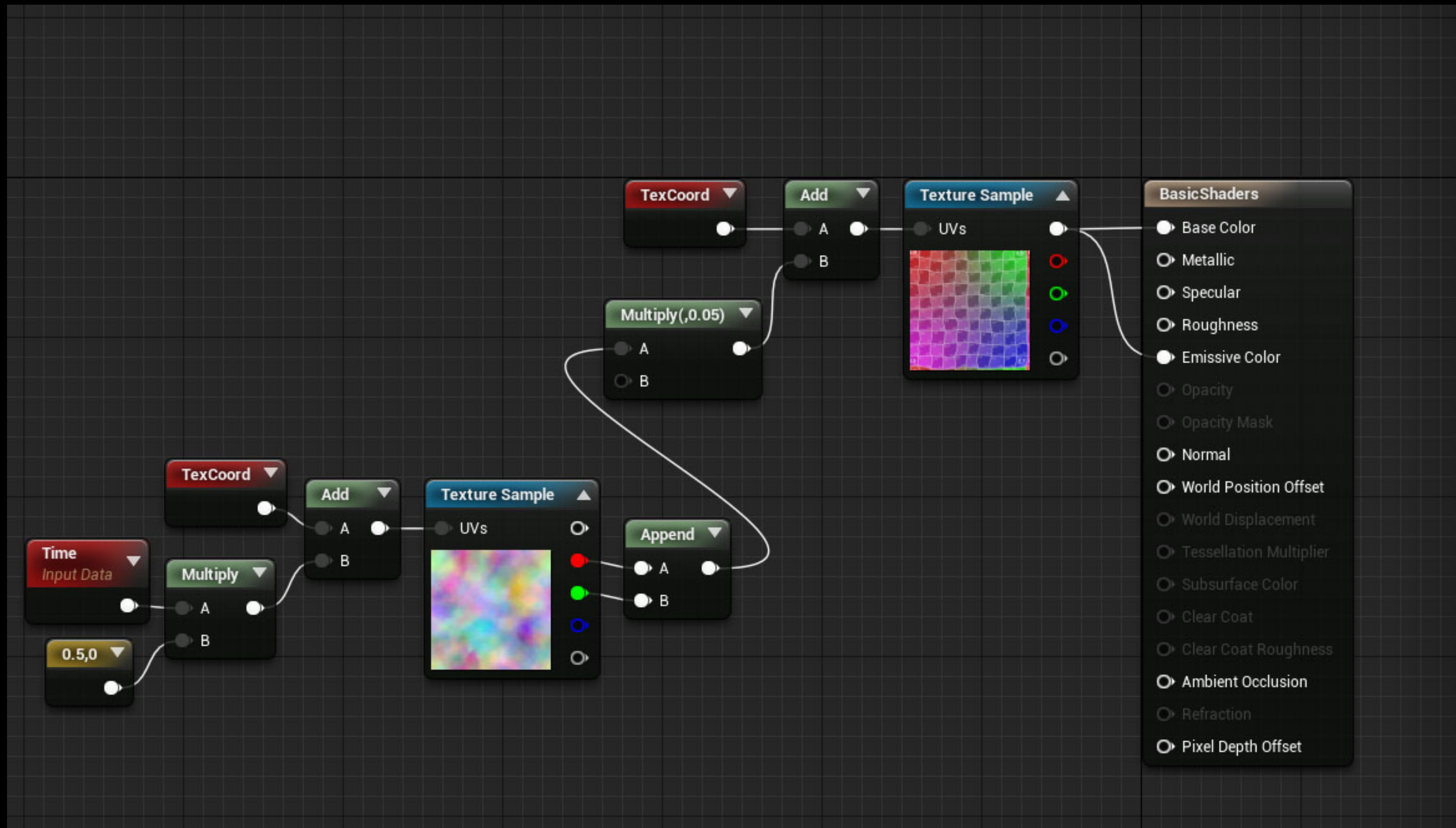
Control Speed With Multiply



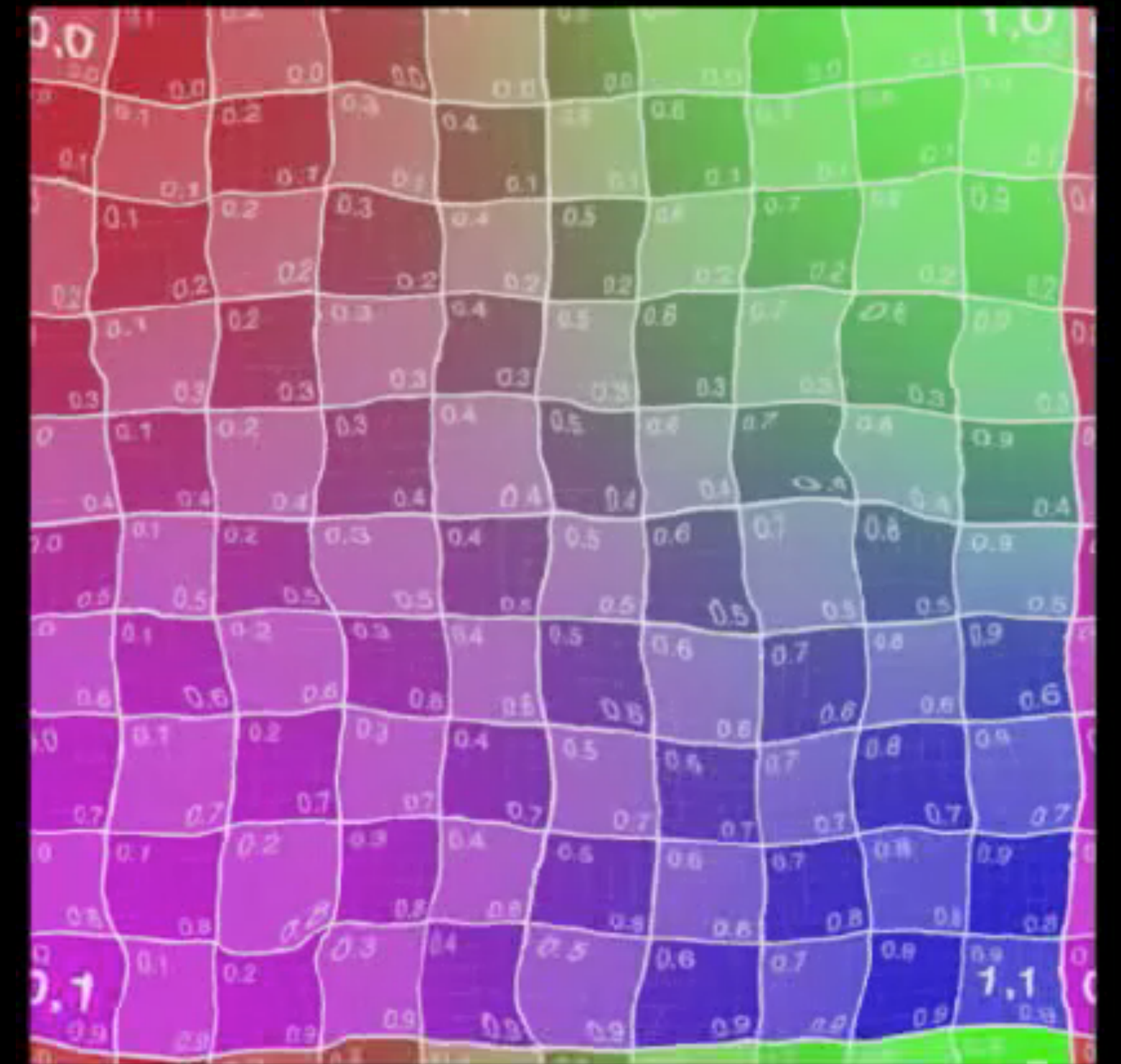
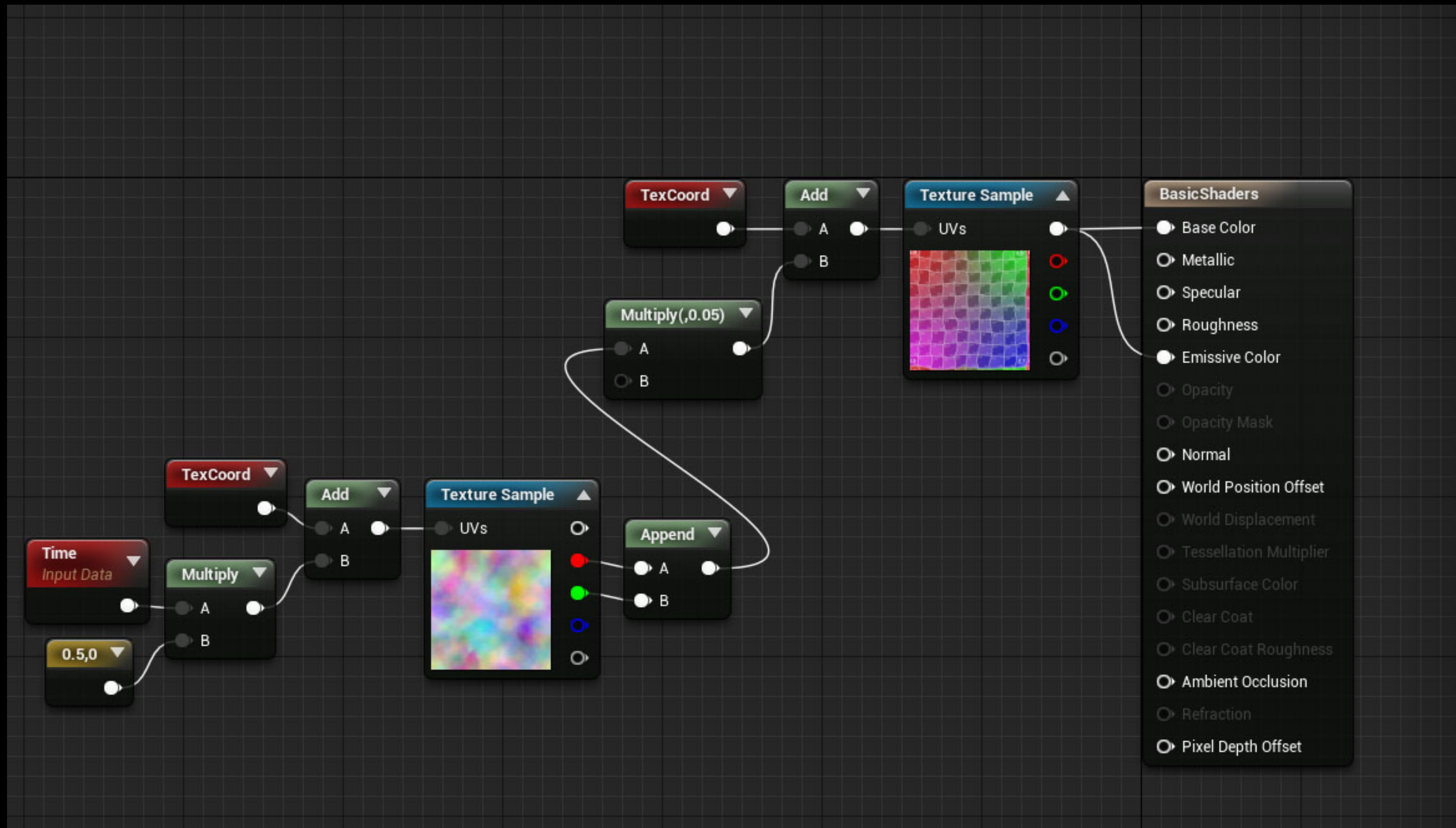
Noise Texture & Append



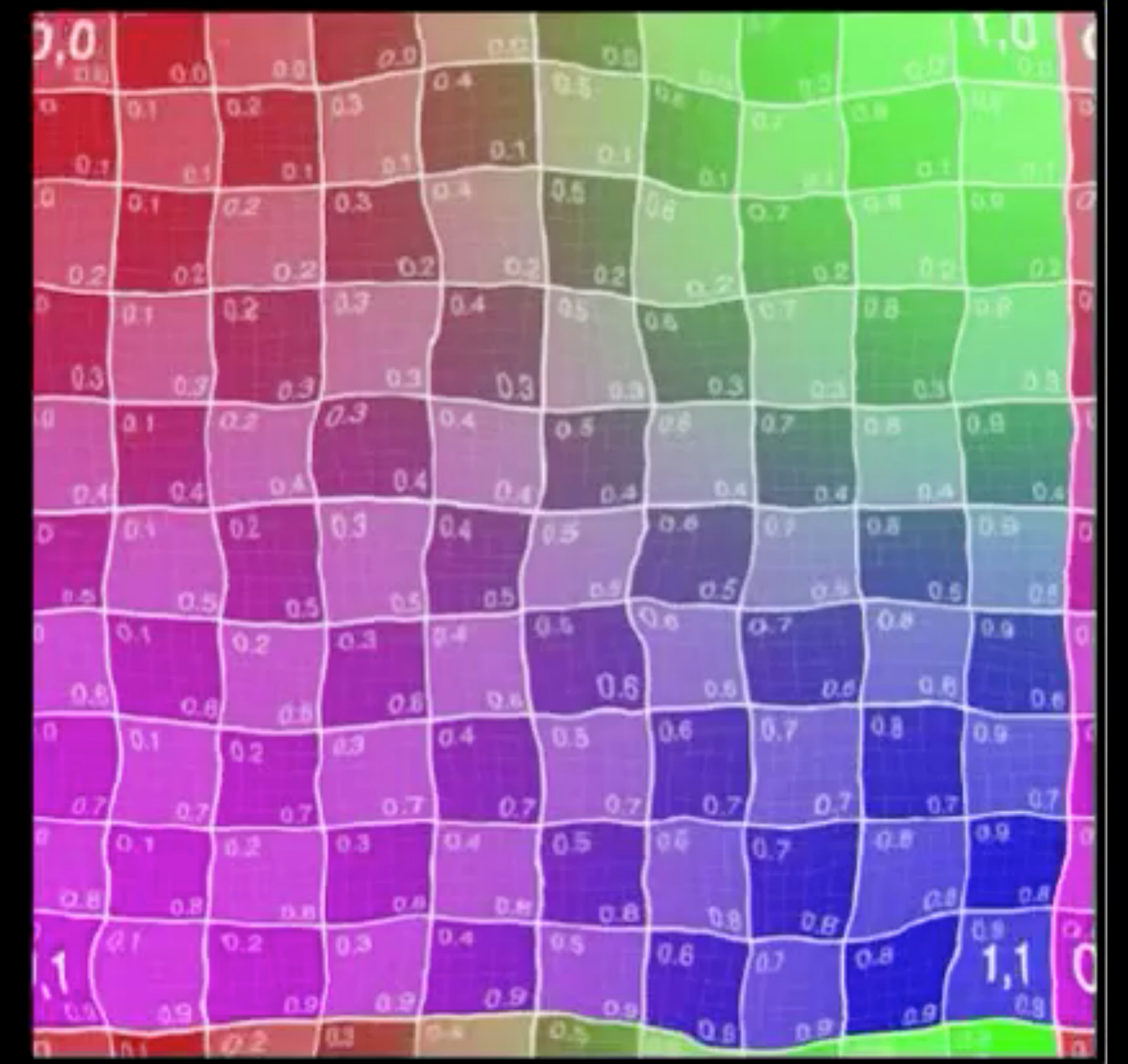
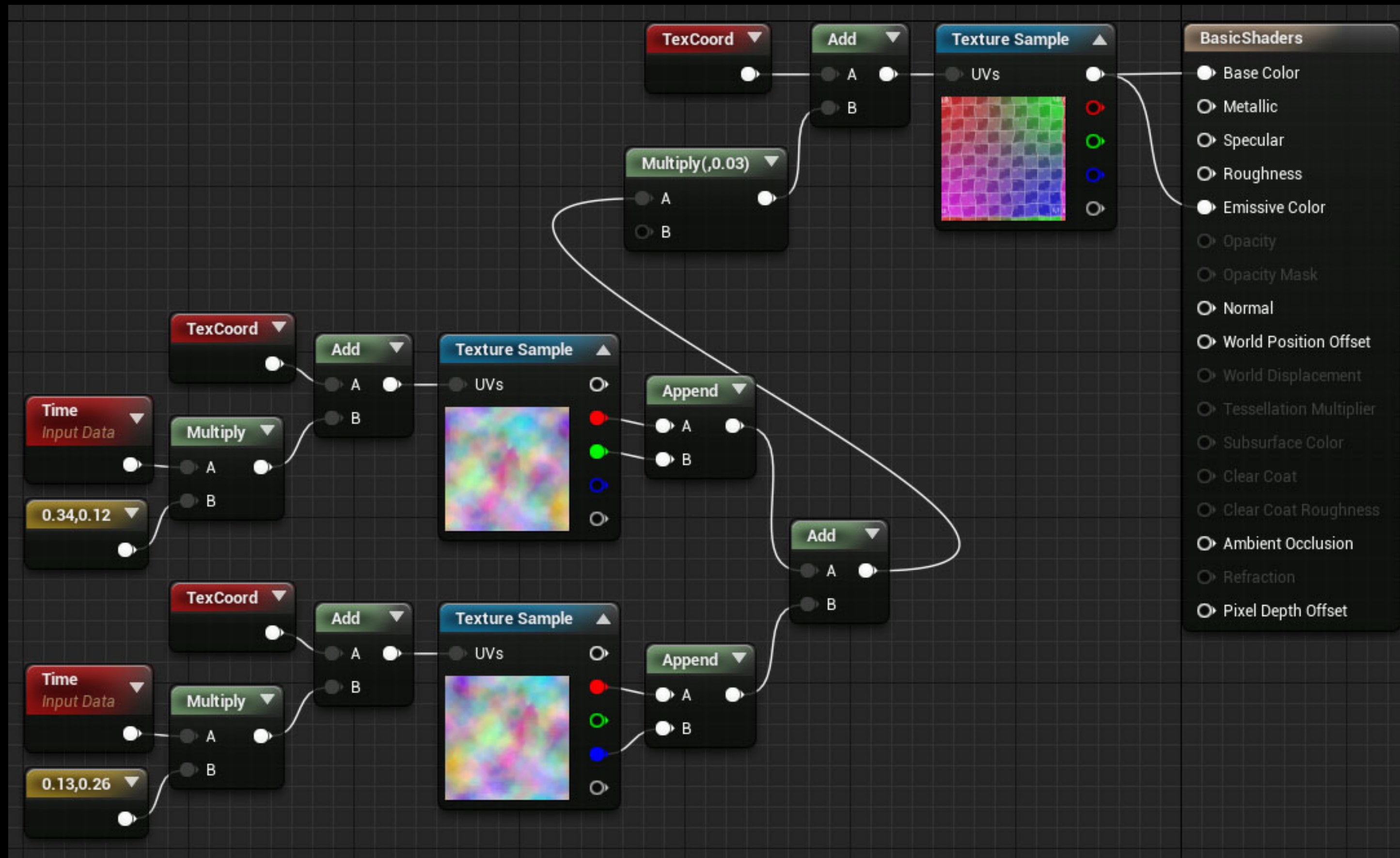
Noise Scrolls & Adds to UVs



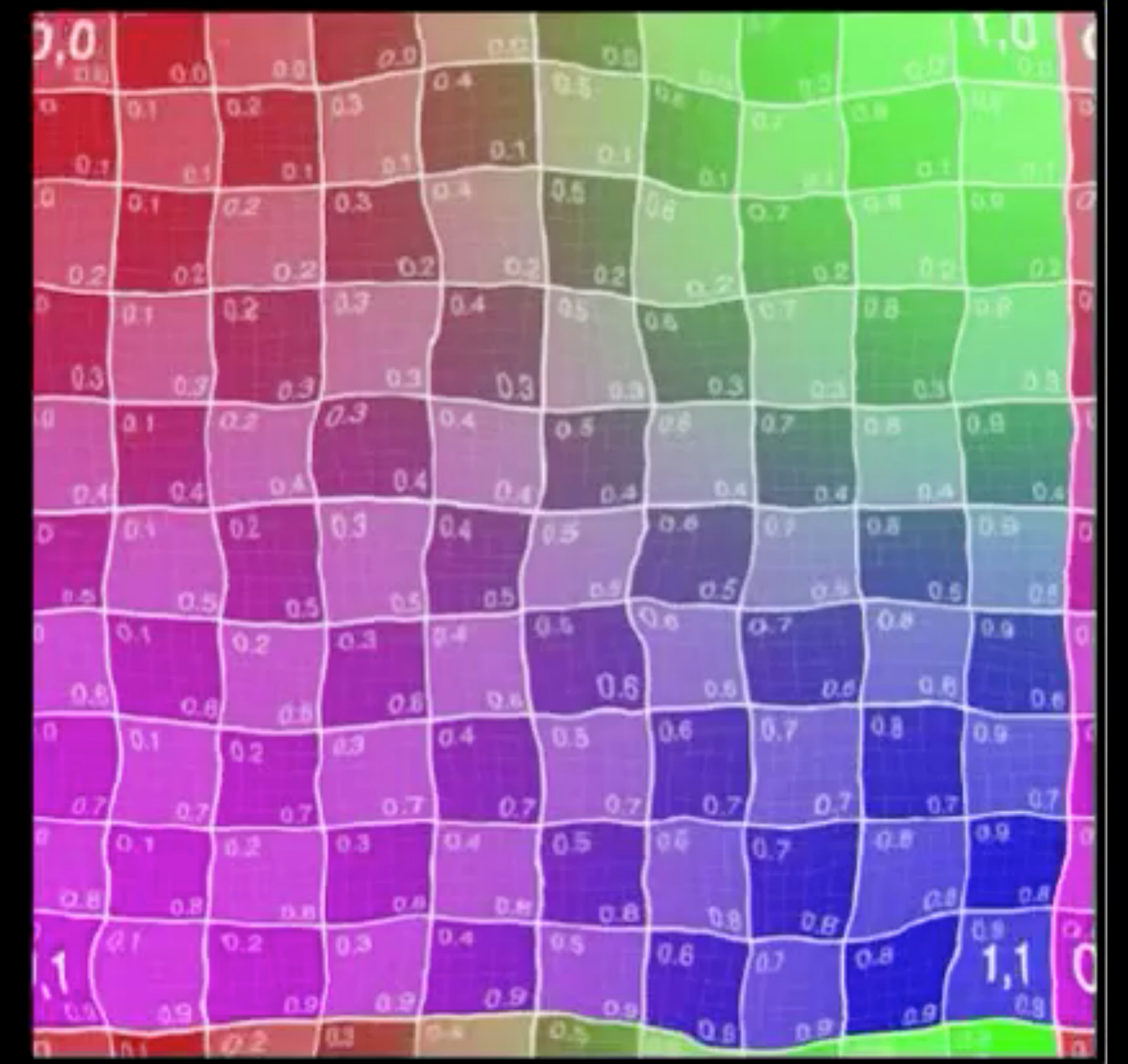
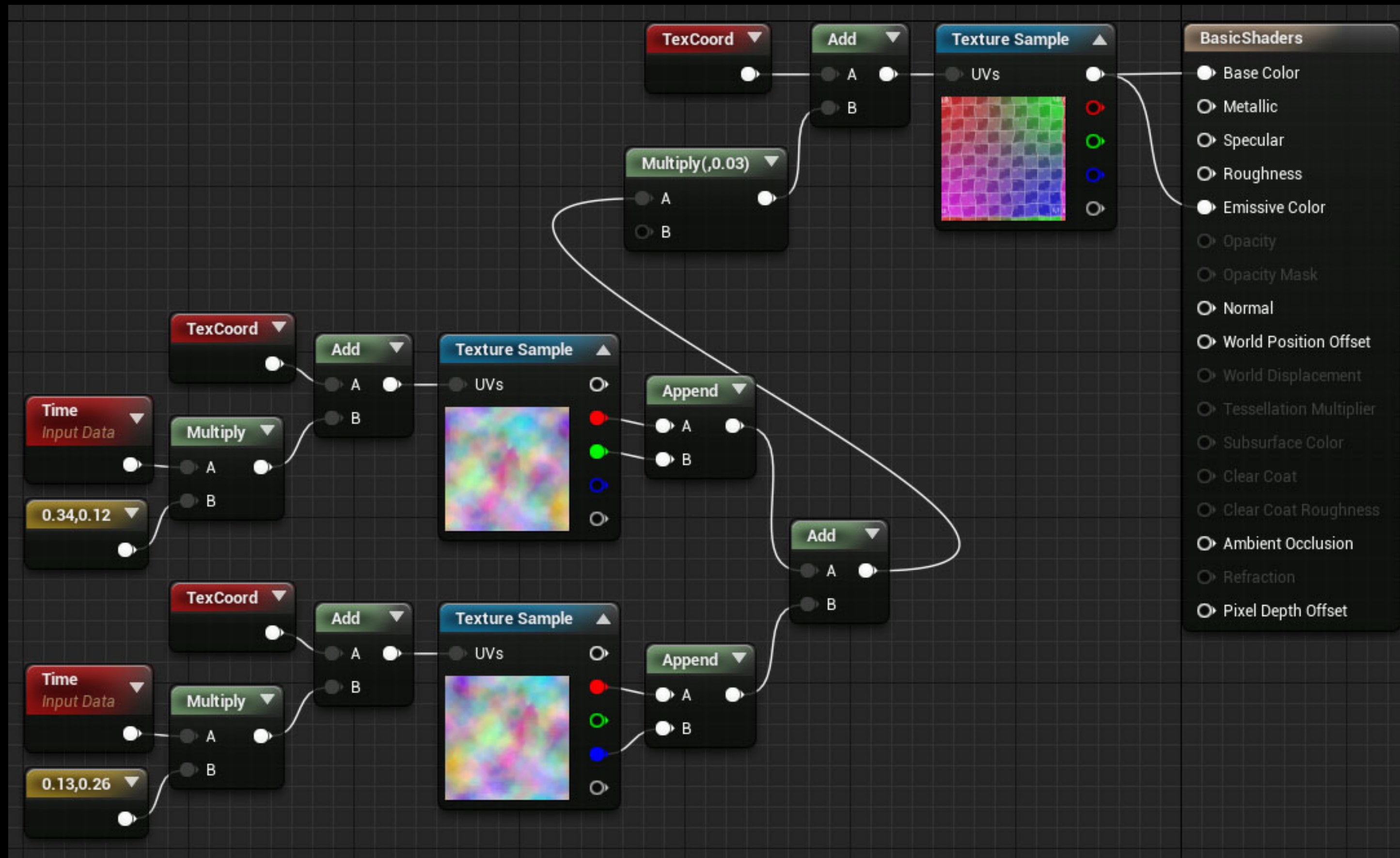
Noise Scrolls & Adds to UVs



More Complex Distortion



More Complex Distortion



Distortion Coordinates Shader Code

```
float2 distortedUVs(float2 originalUVs, float distortionStrength, )  
{  
    float2 distortionCoord1 = (float2(0.34, 0.12) * time) + originalUVs;  
    float2 distortionCoord2 = (float2(0.13, 0.26) * time) + originalUVs;  
    float2 distortion1 = tex2D(DistortionTextureSampler, distortionCoord1).xy;  
    float2 distortion2 = tex2D(DistortionTextureSampler, distortionCoord2).xy;  
    return (distortion1 + distortion2) * distortionStrength;  
}
```

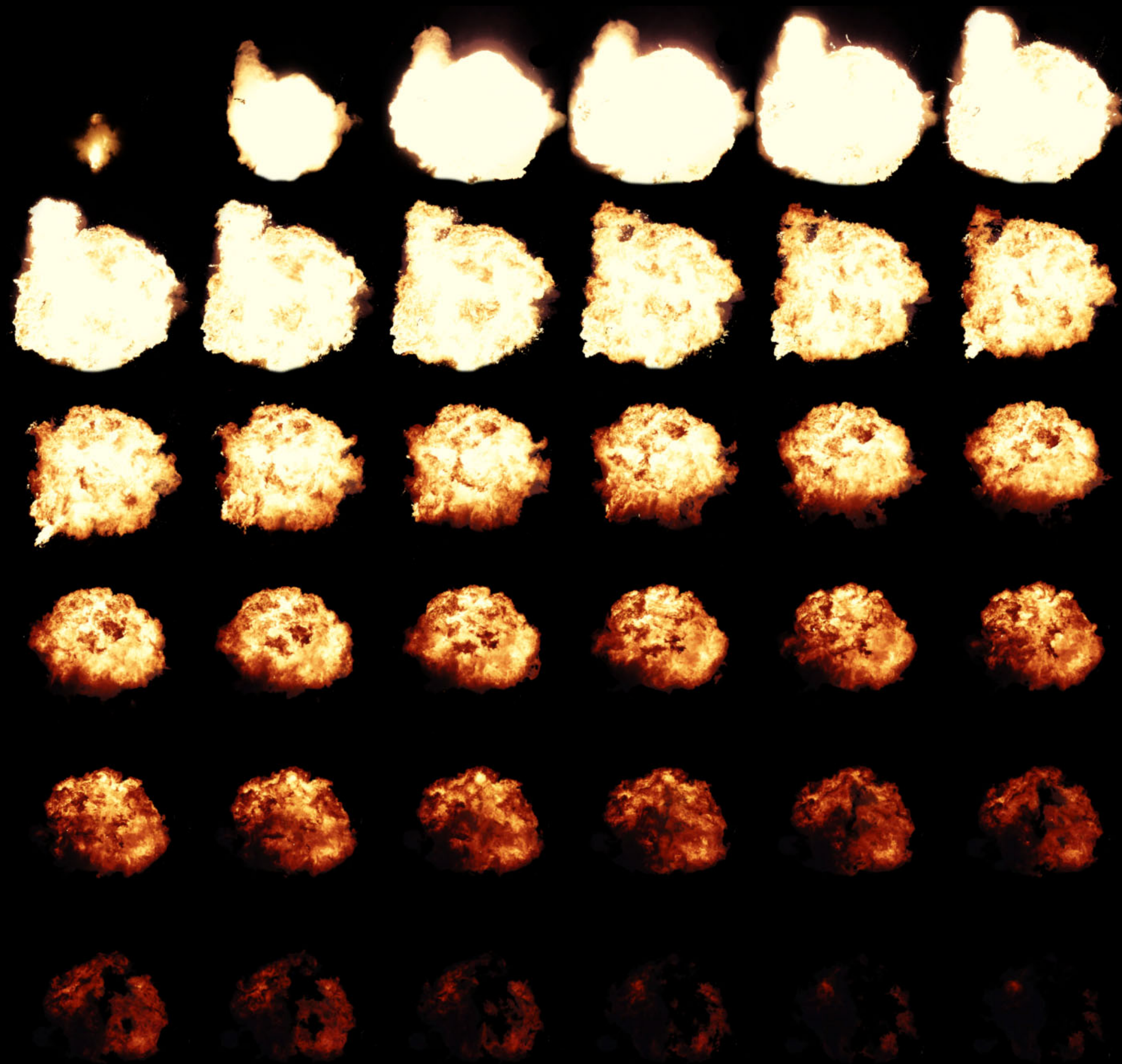

Atlas Walk Example



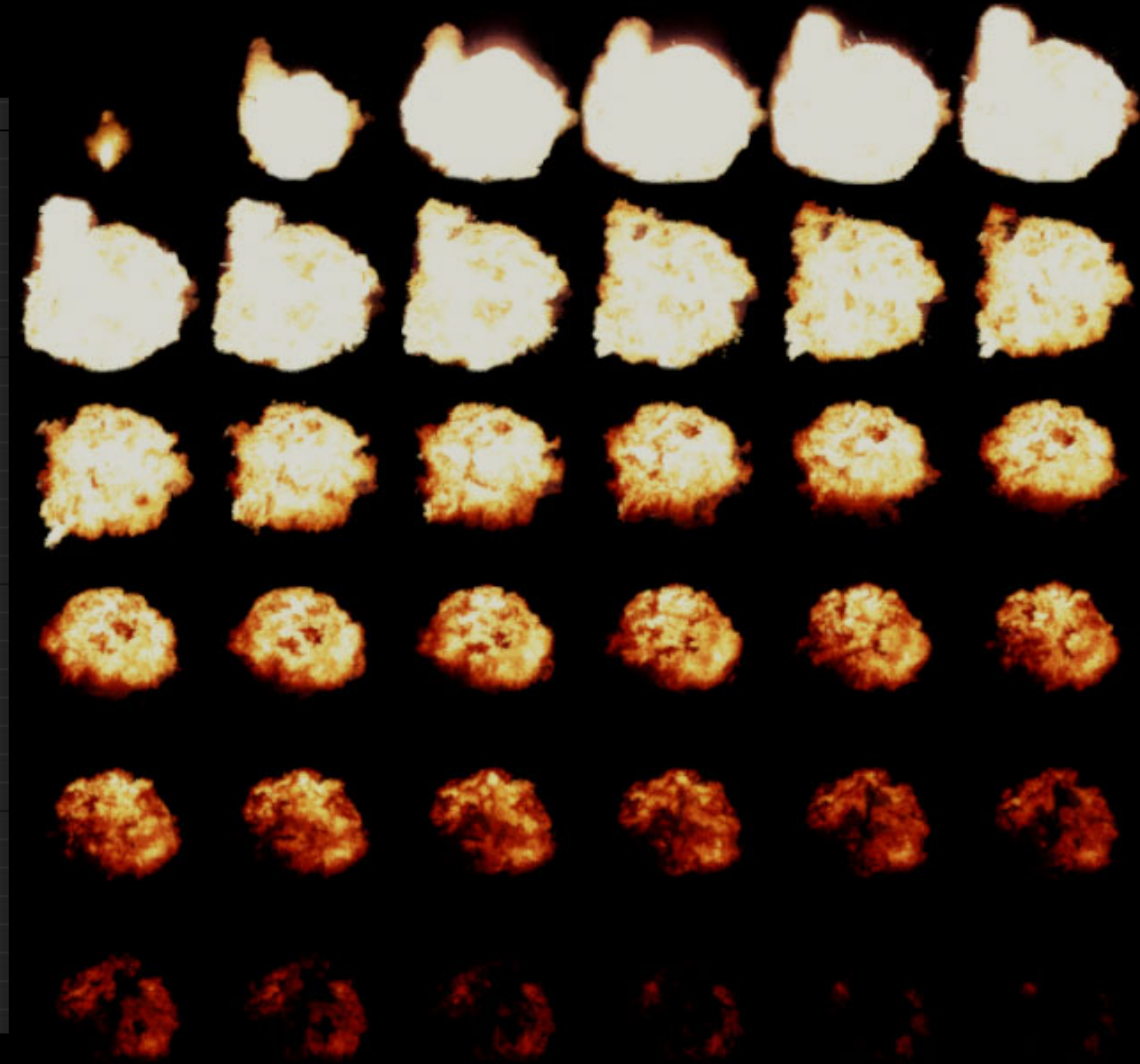
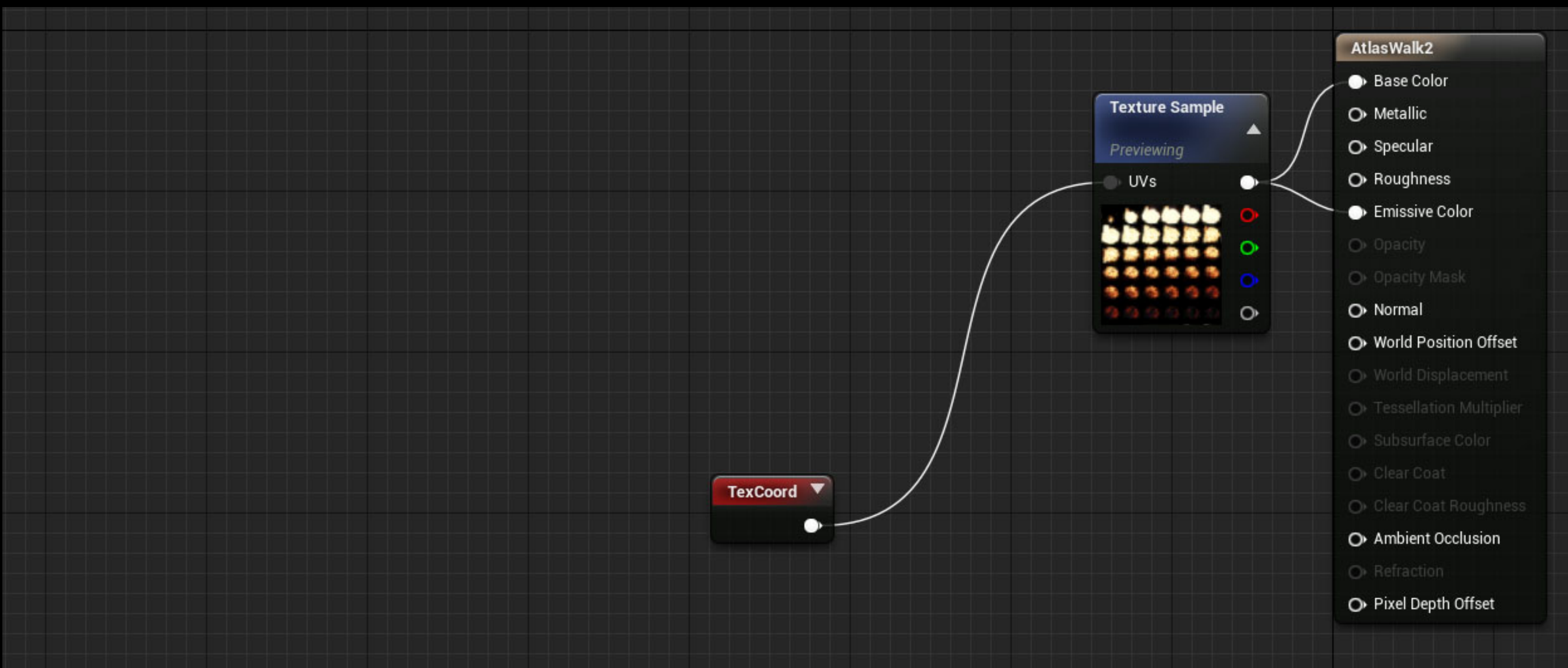
Atlas Walk Example



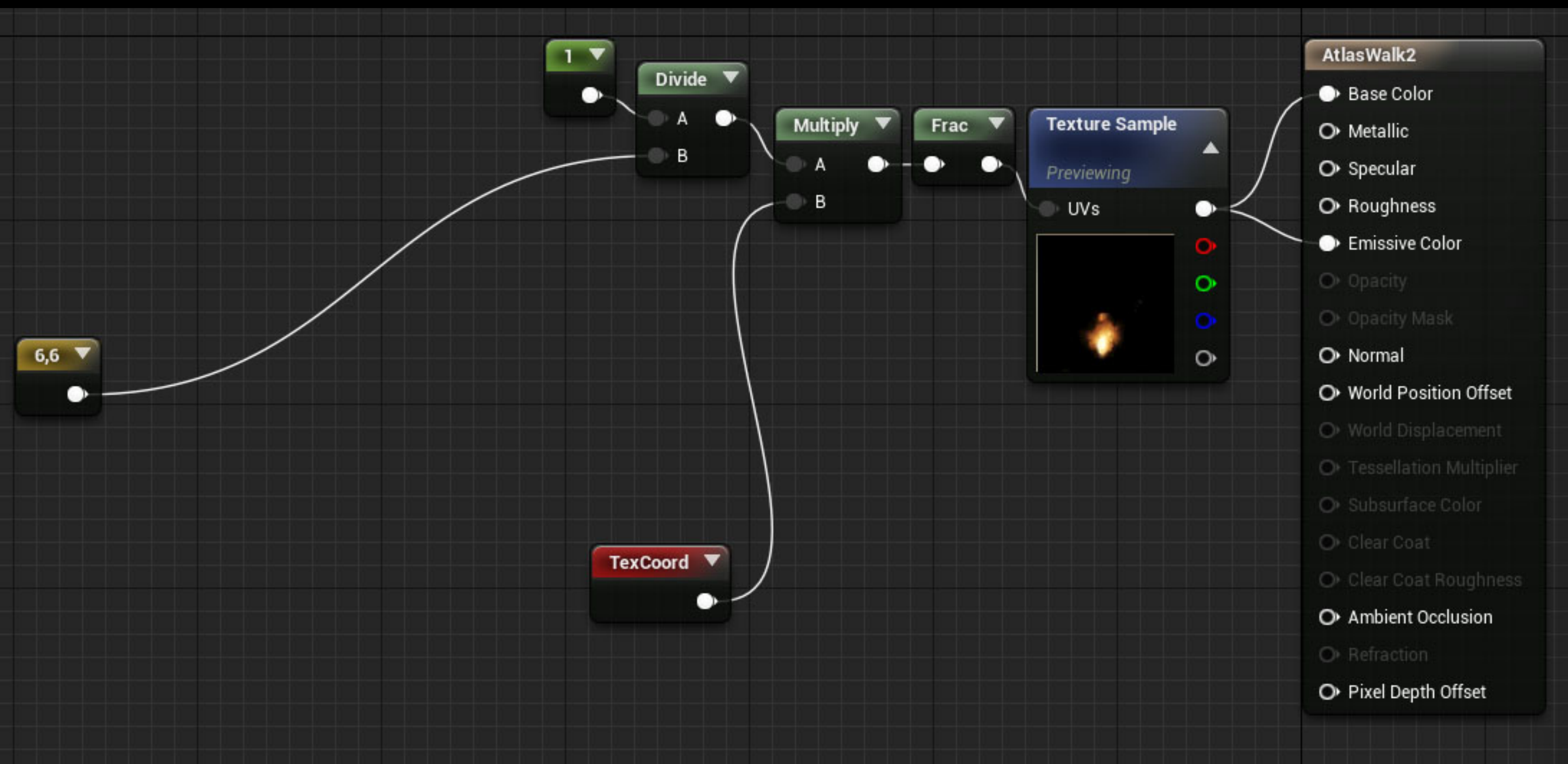
Atlas Texture



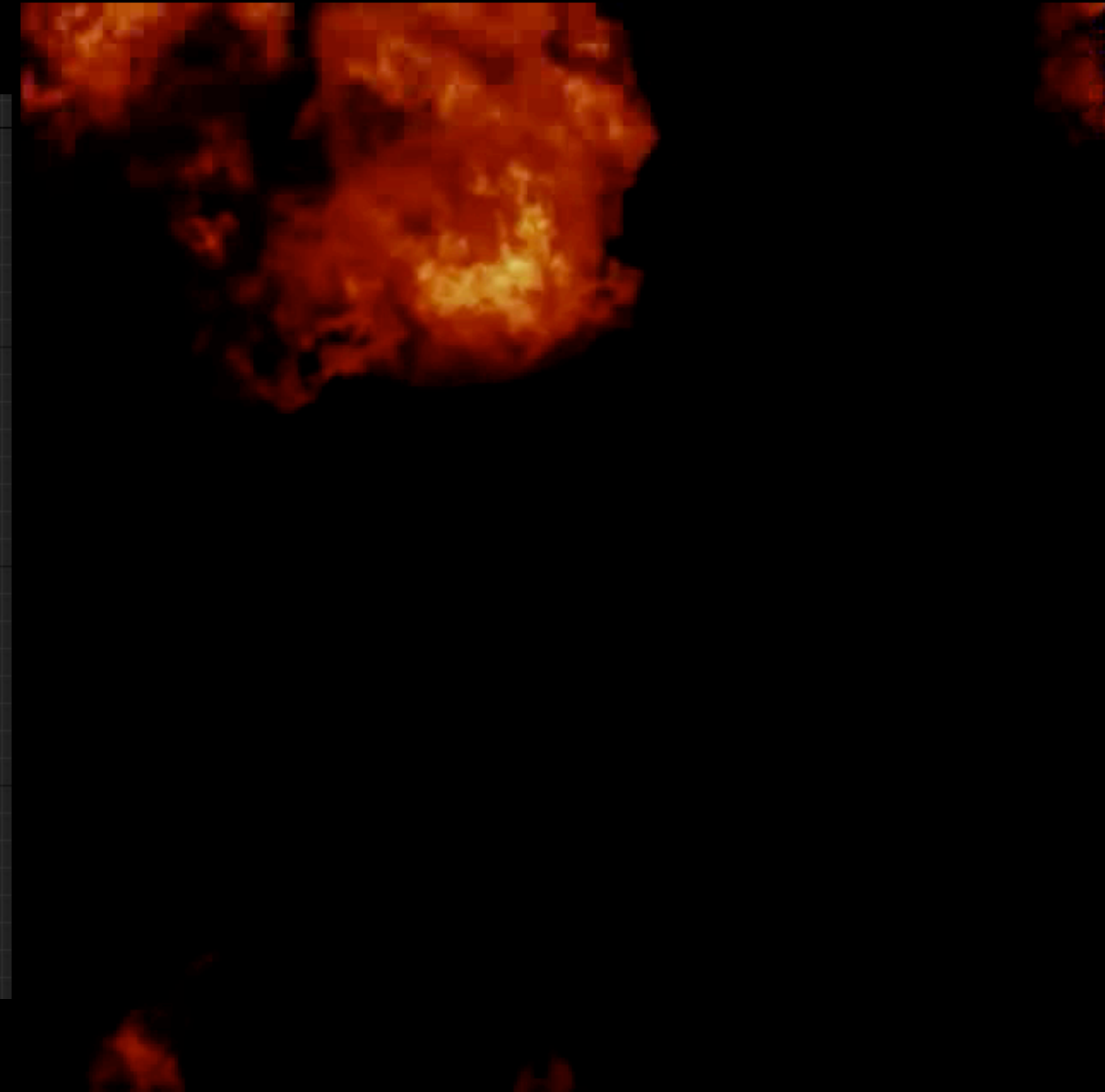
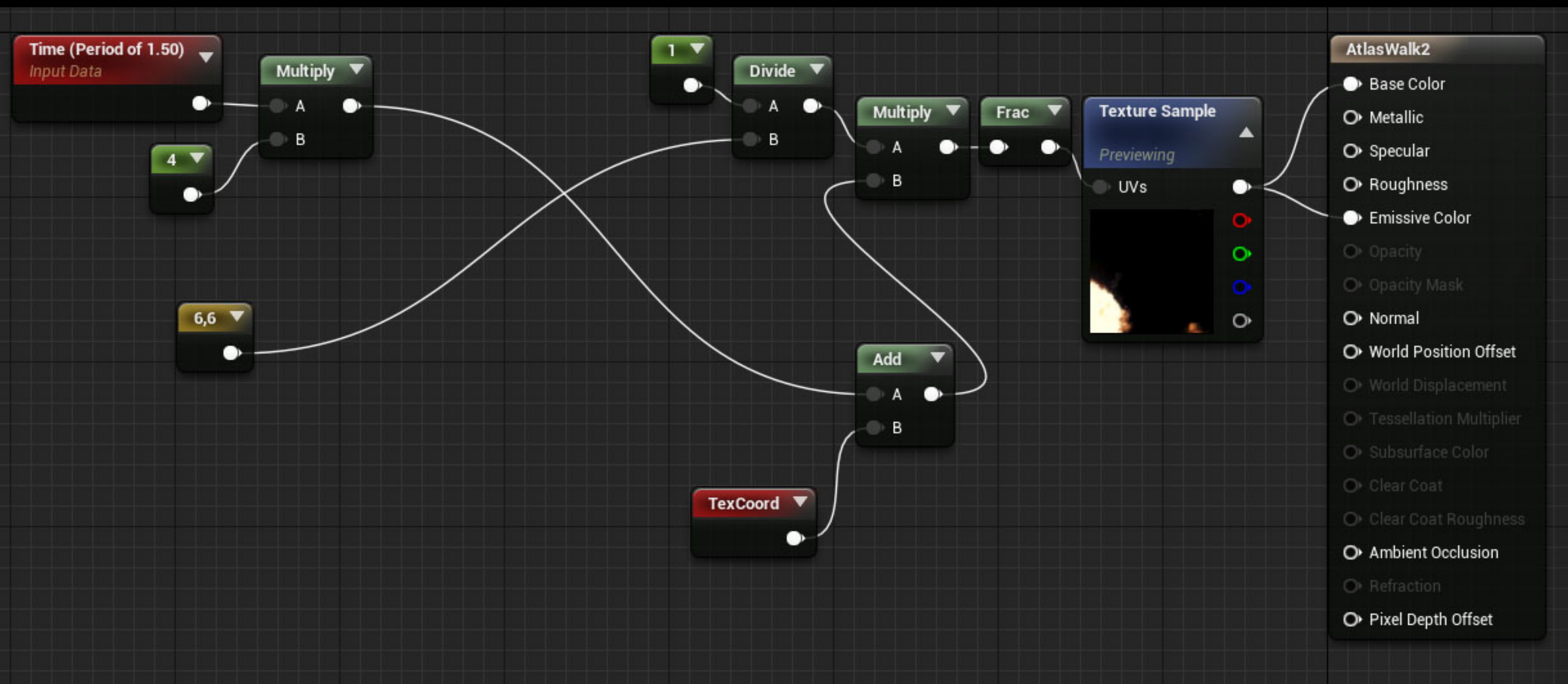
Sample the Atlas



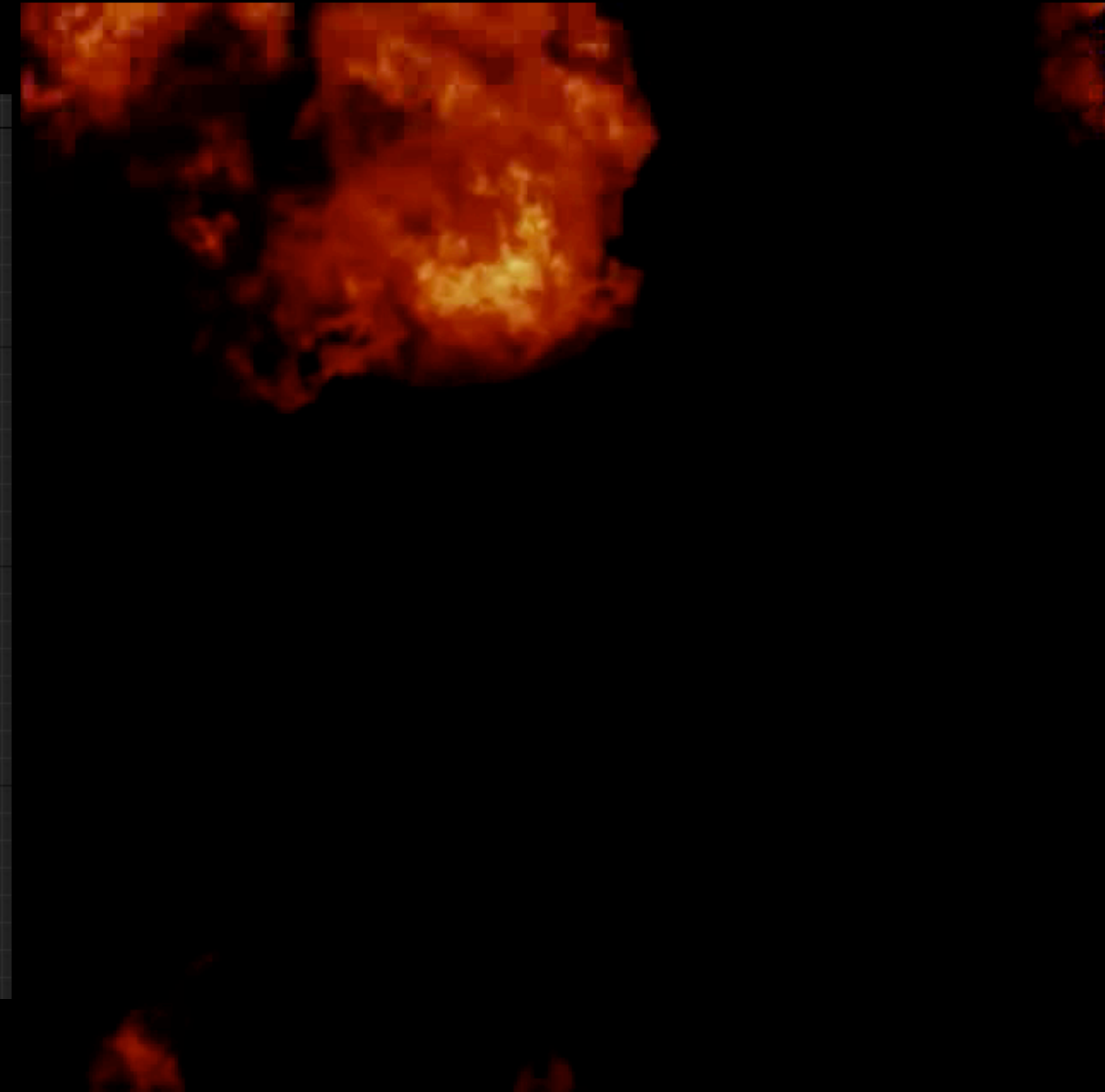
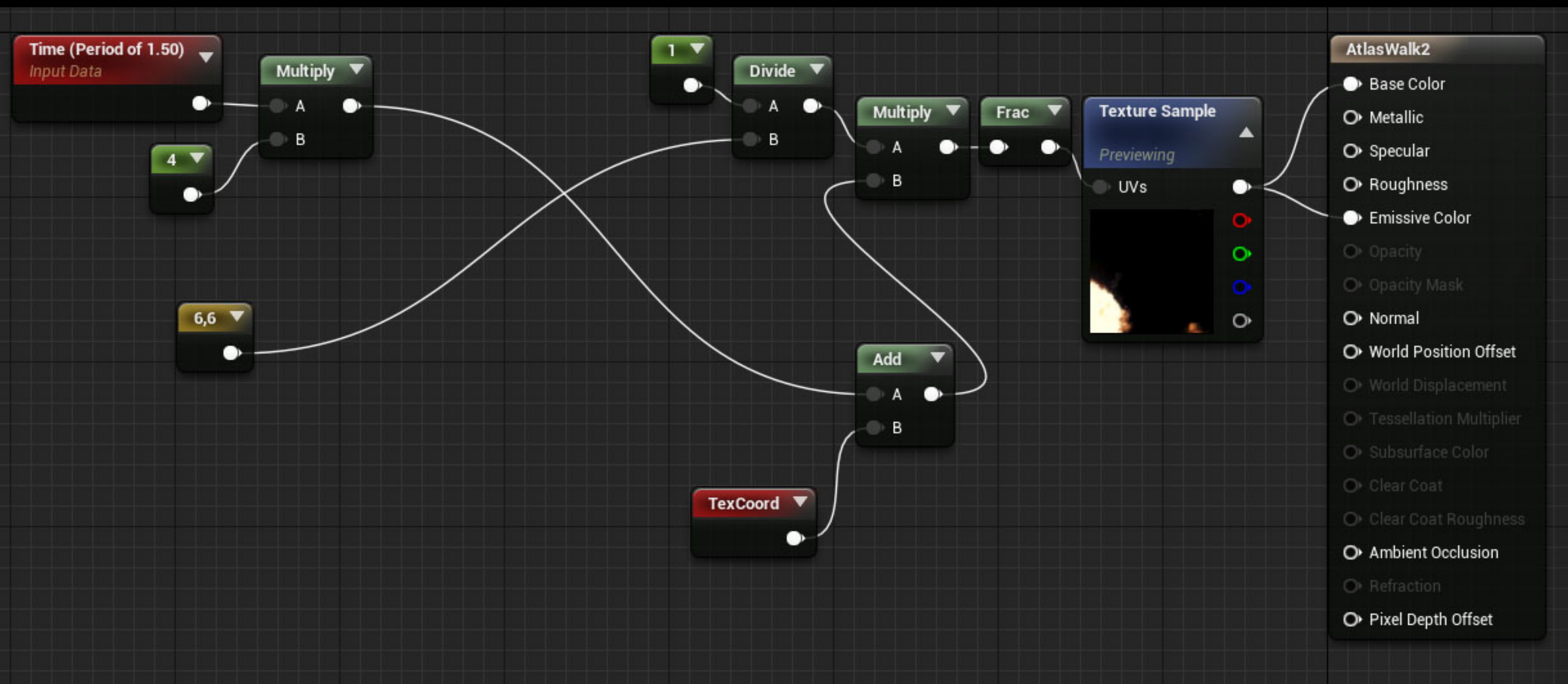
Scale Atlas to One Frame



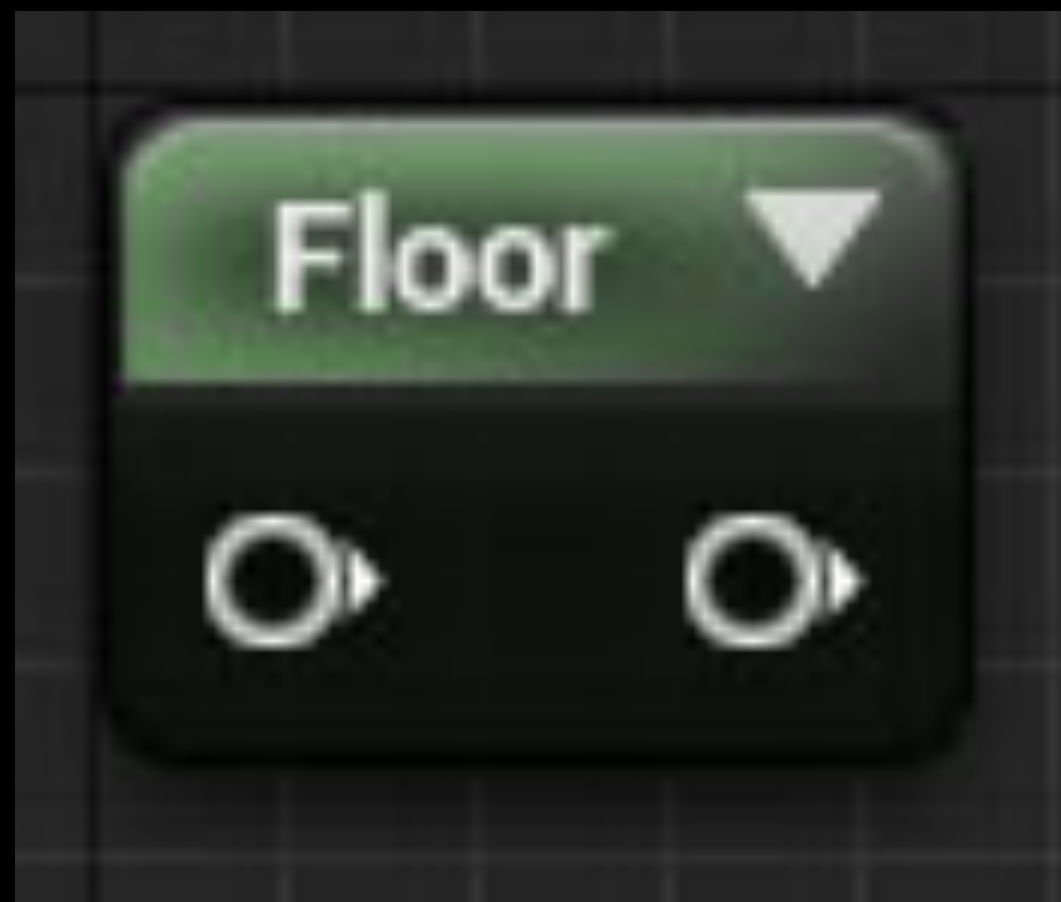
Scroll the Atlas



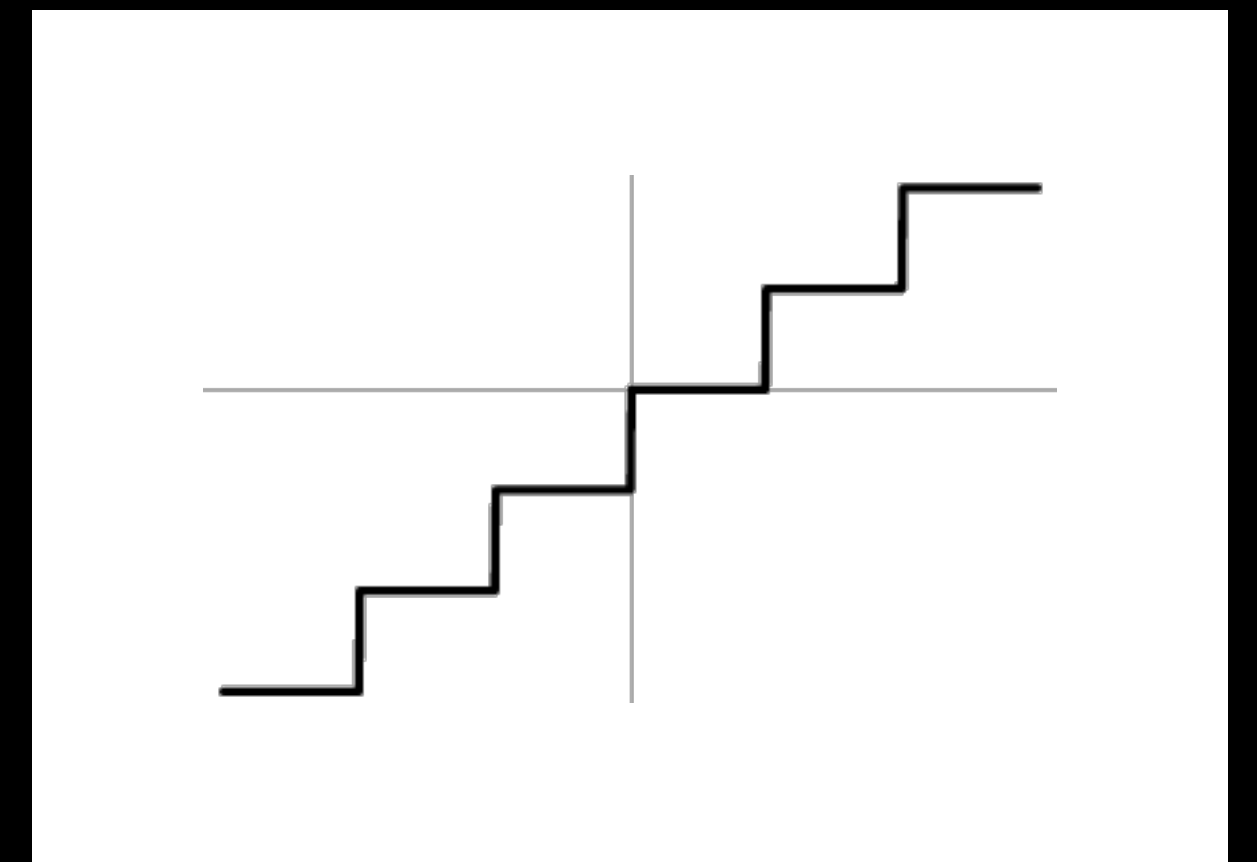
Scroll the Atlas



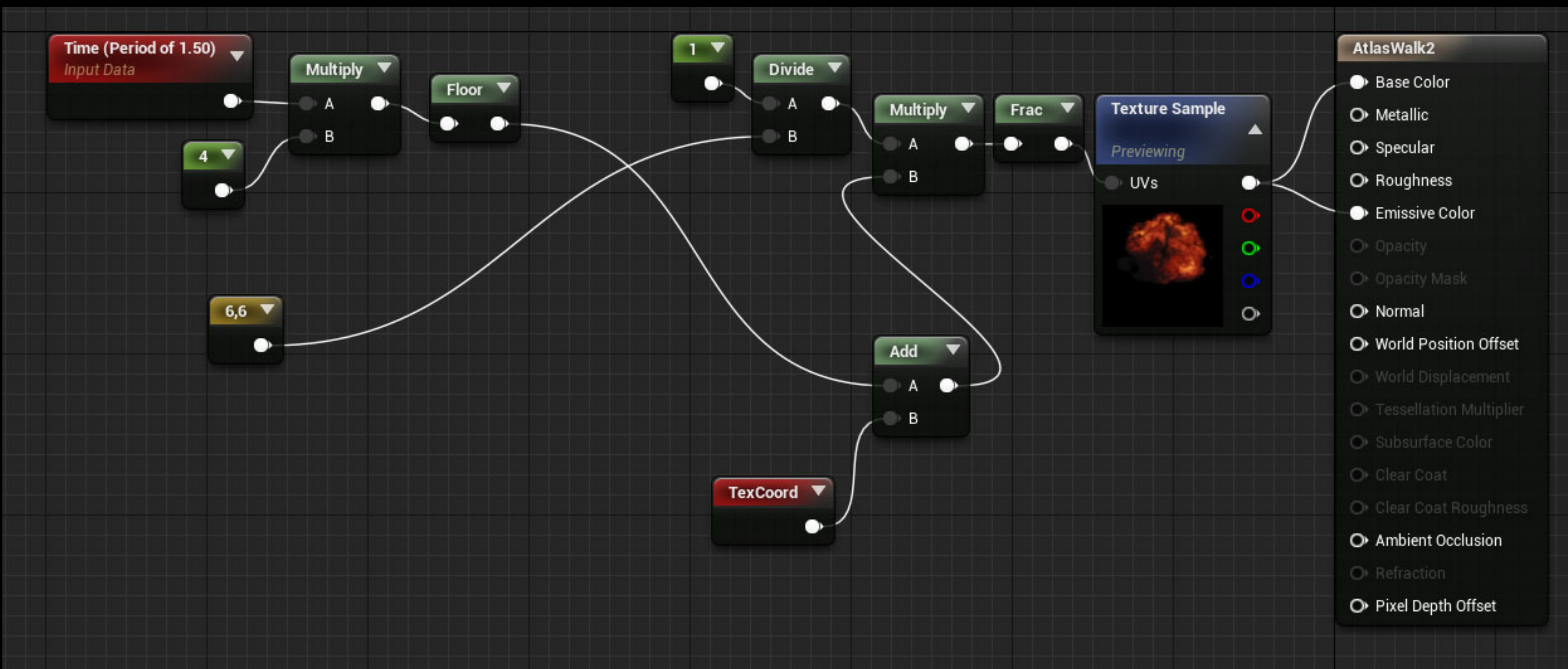
Floor



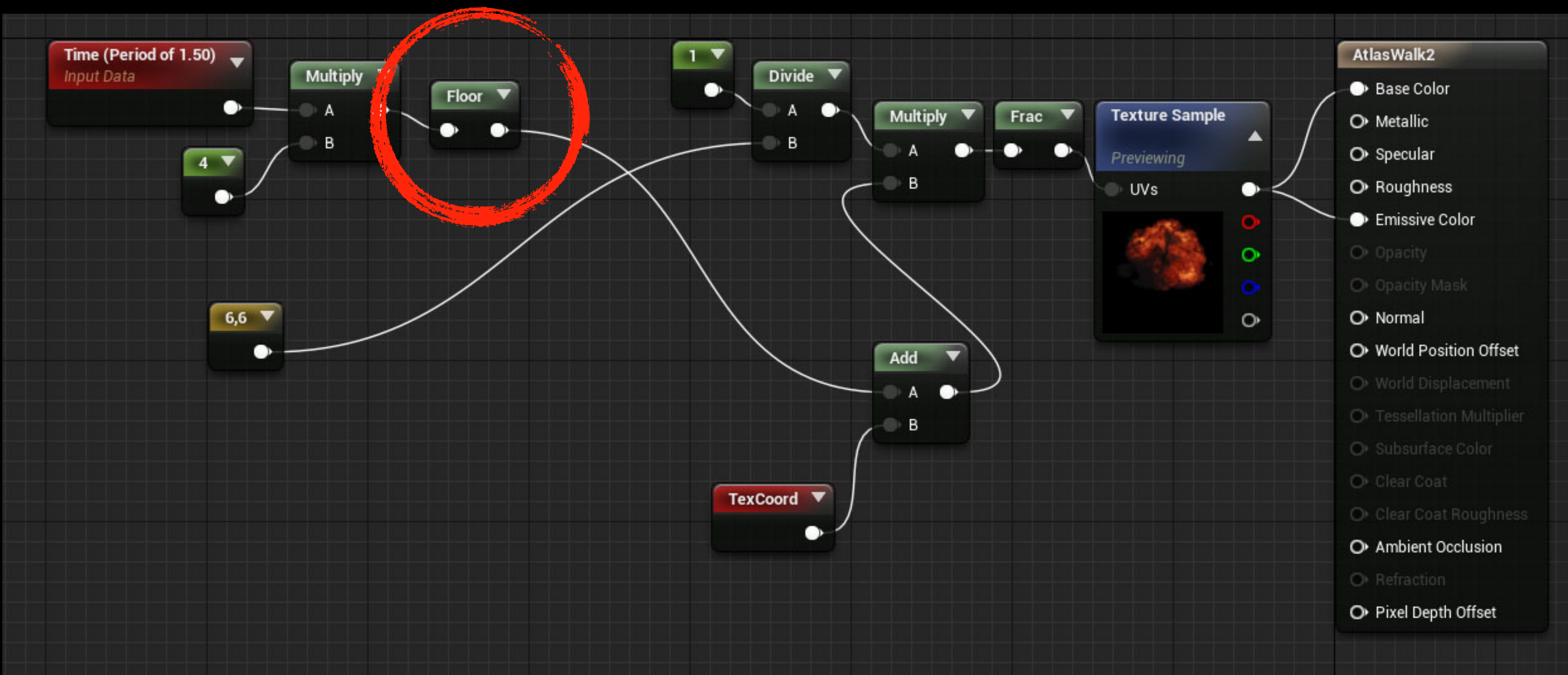
Floor



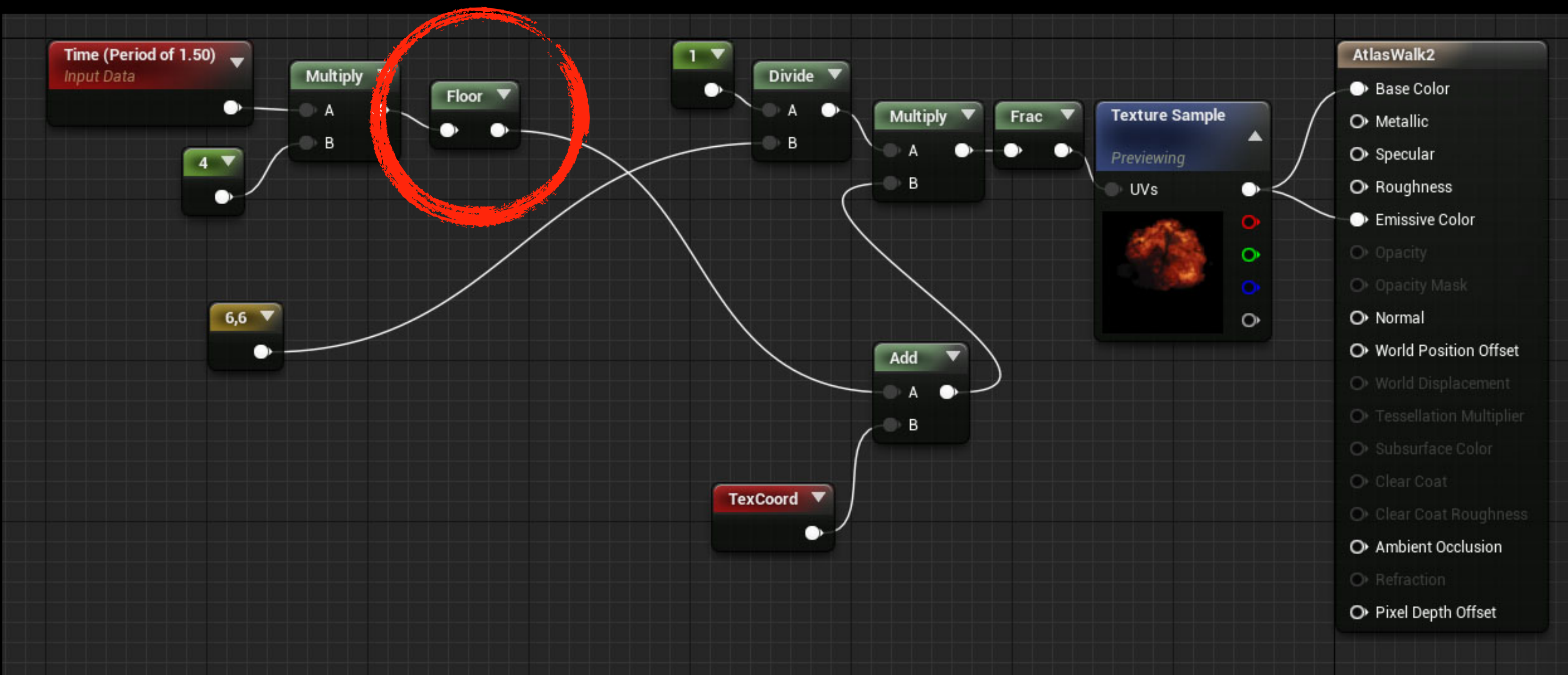
Floor Steps Through Time



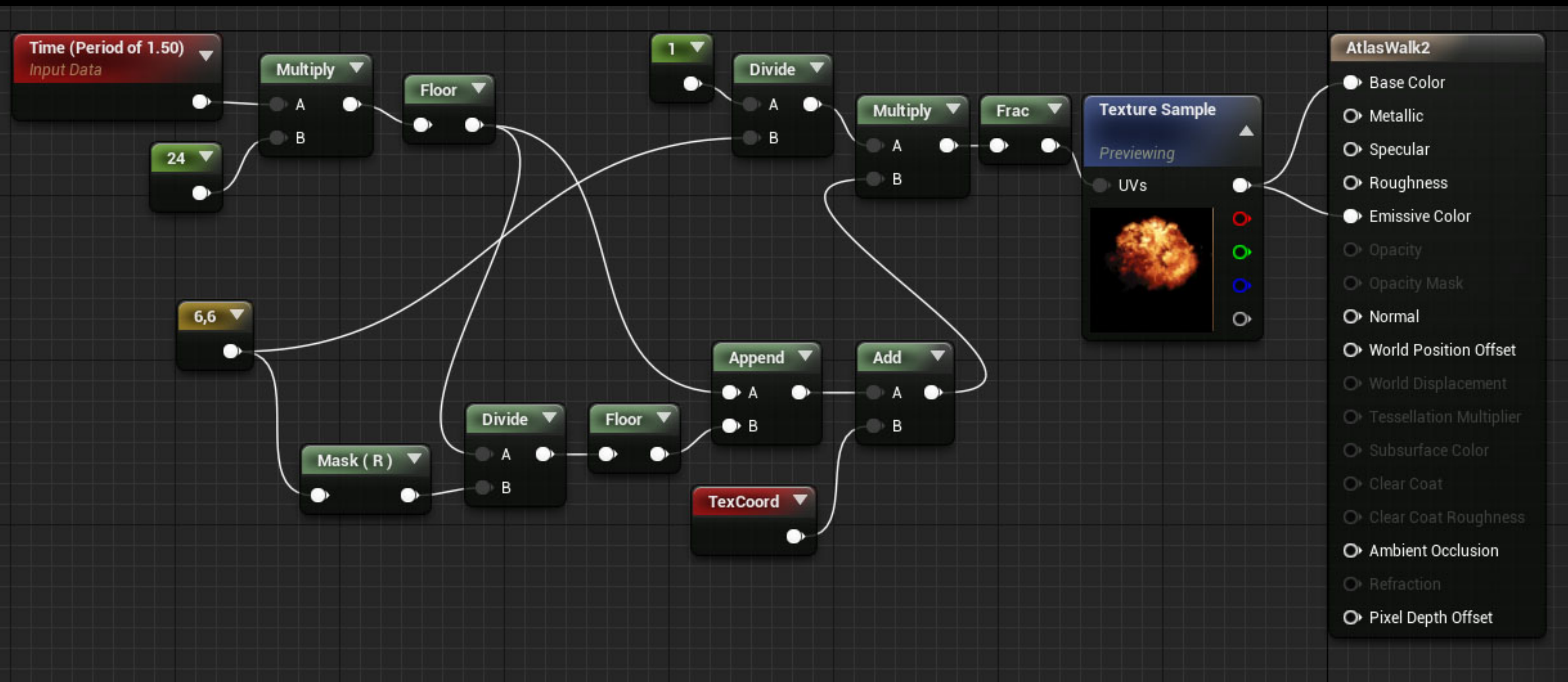
Floor Steps Through Time



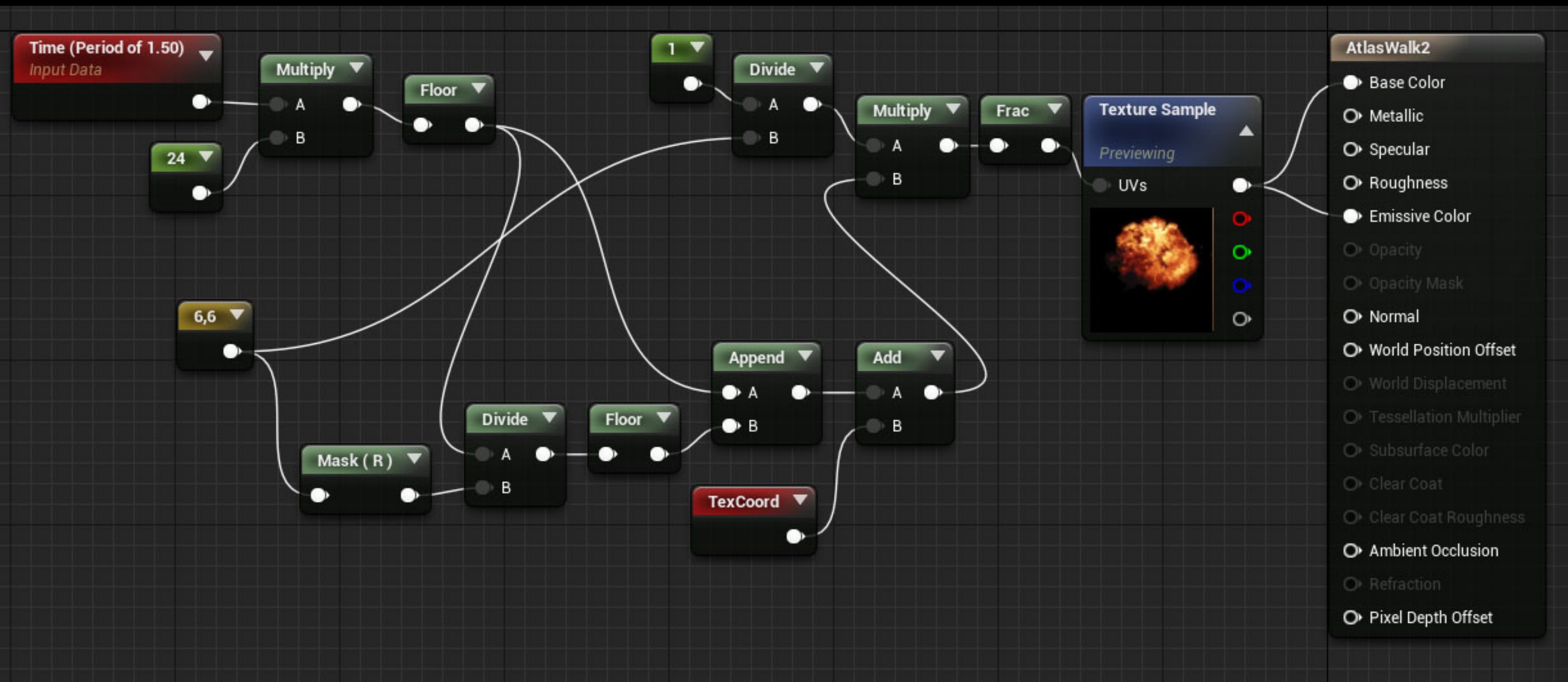
Floor Steps Through Time



Step in X & Jump in Y



Step in X & Jump in Y



Atlas Walk Shader Code

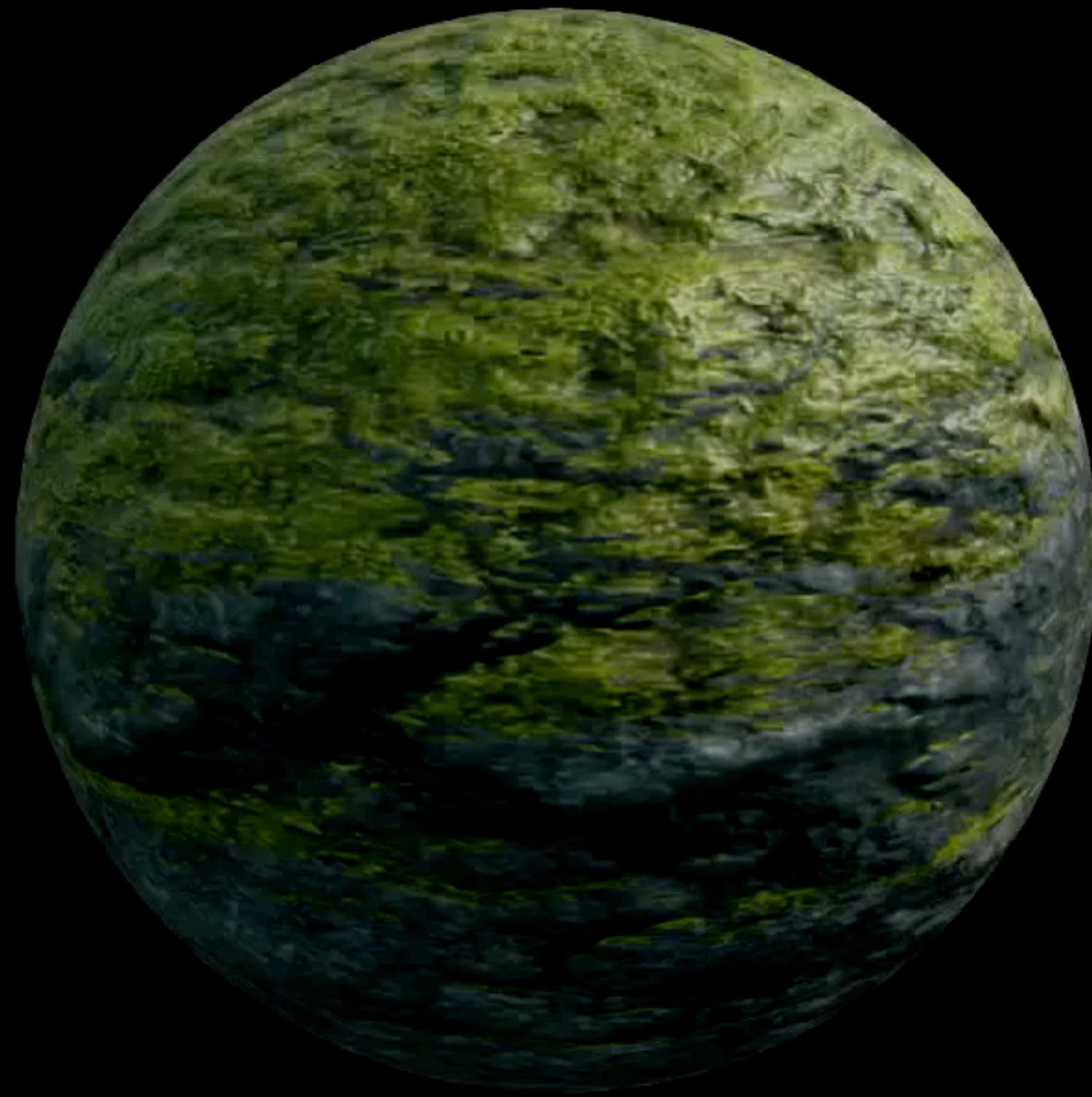
```
float2 atlasWalkUVs(float2 dimensions, float2 uvCoords, float fps, float time)
{
    float steppingTime = floor(time * fps);

    float jumpingY = floor(steppingTime / dimensions.y);

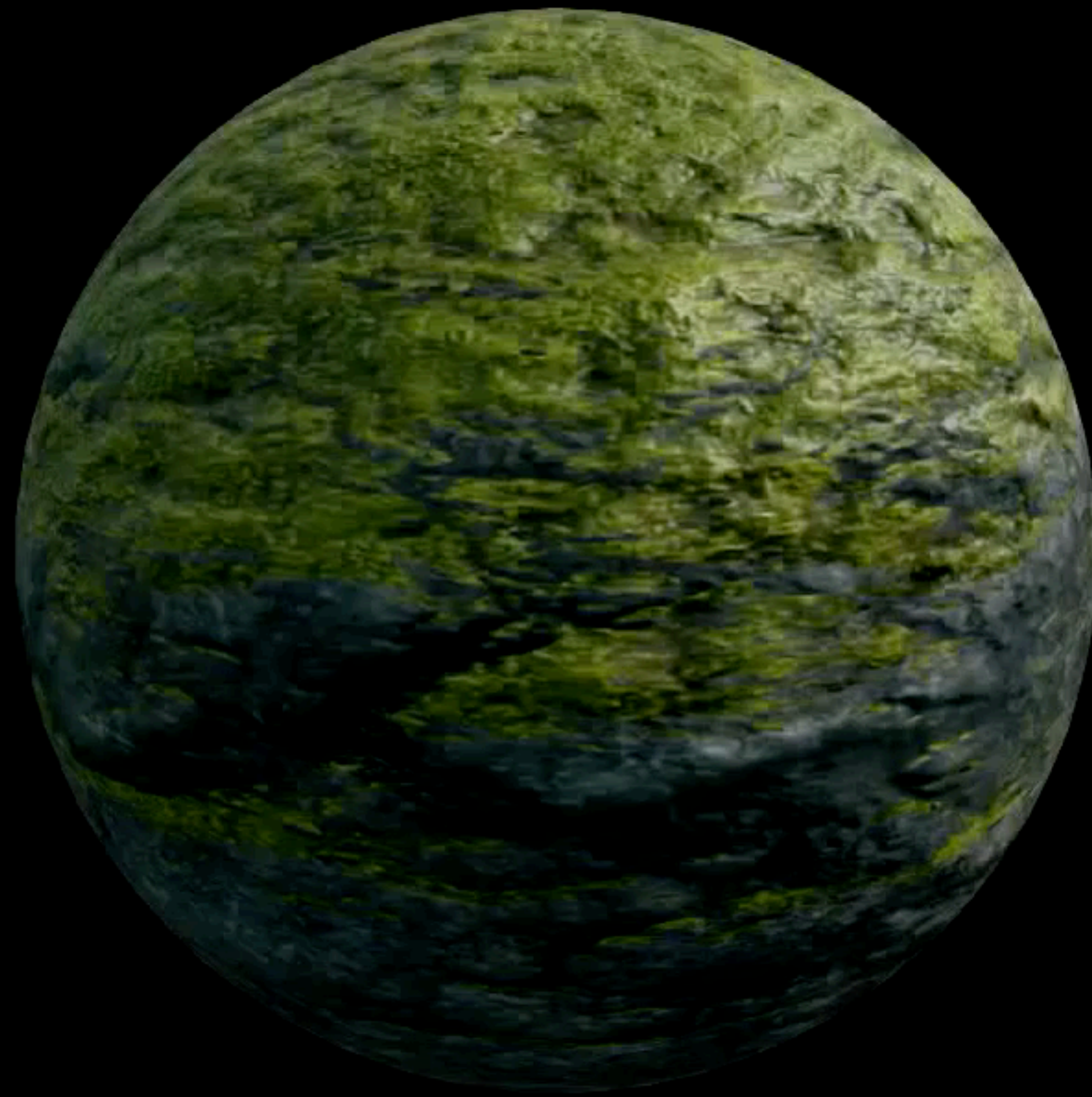
    float2 newUVs = float2(steppingTime, jumpingY) + uvCoords;

    return frac(newUVs * (1/dimensions));
}
```

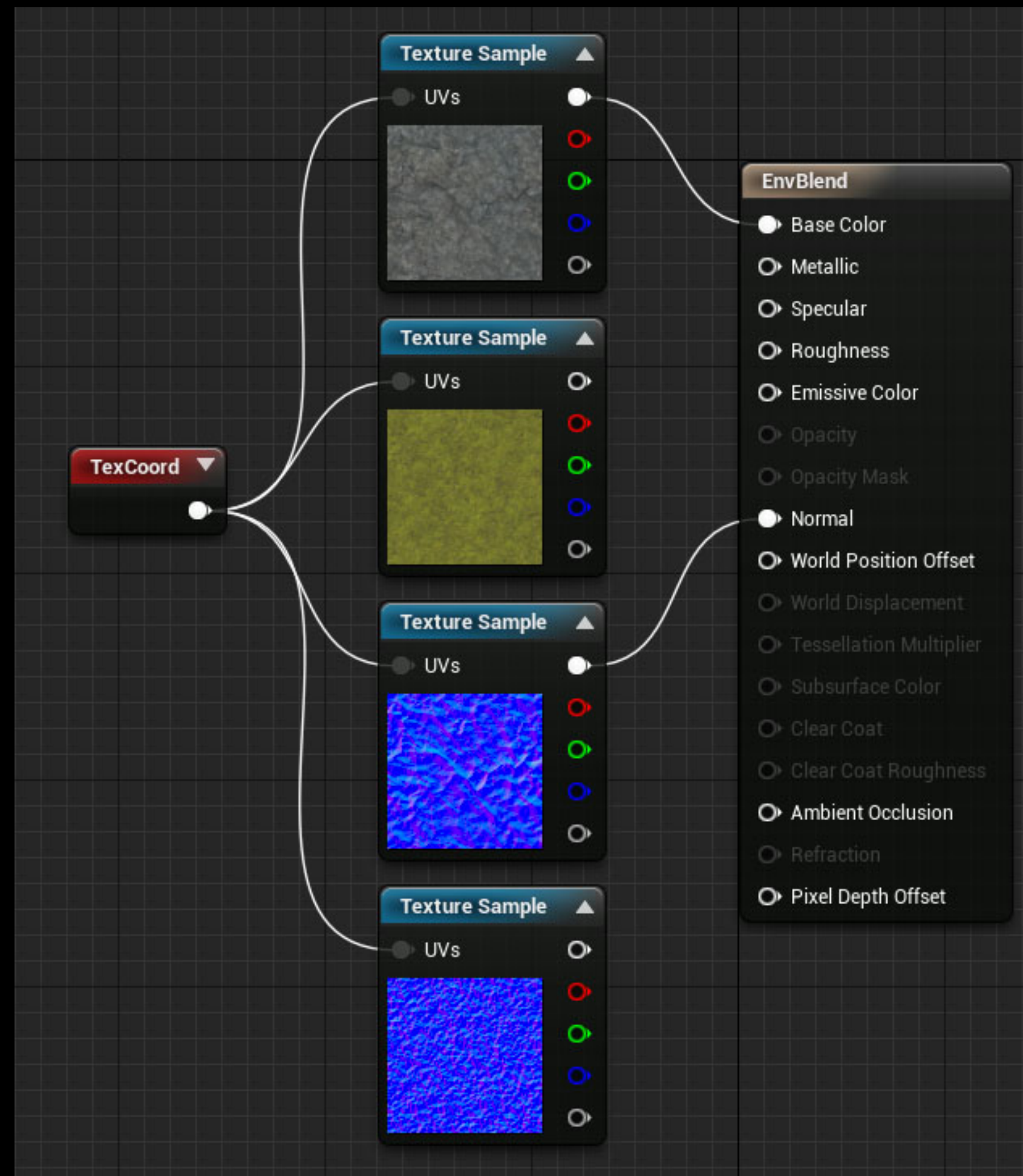
Environment Blending Example



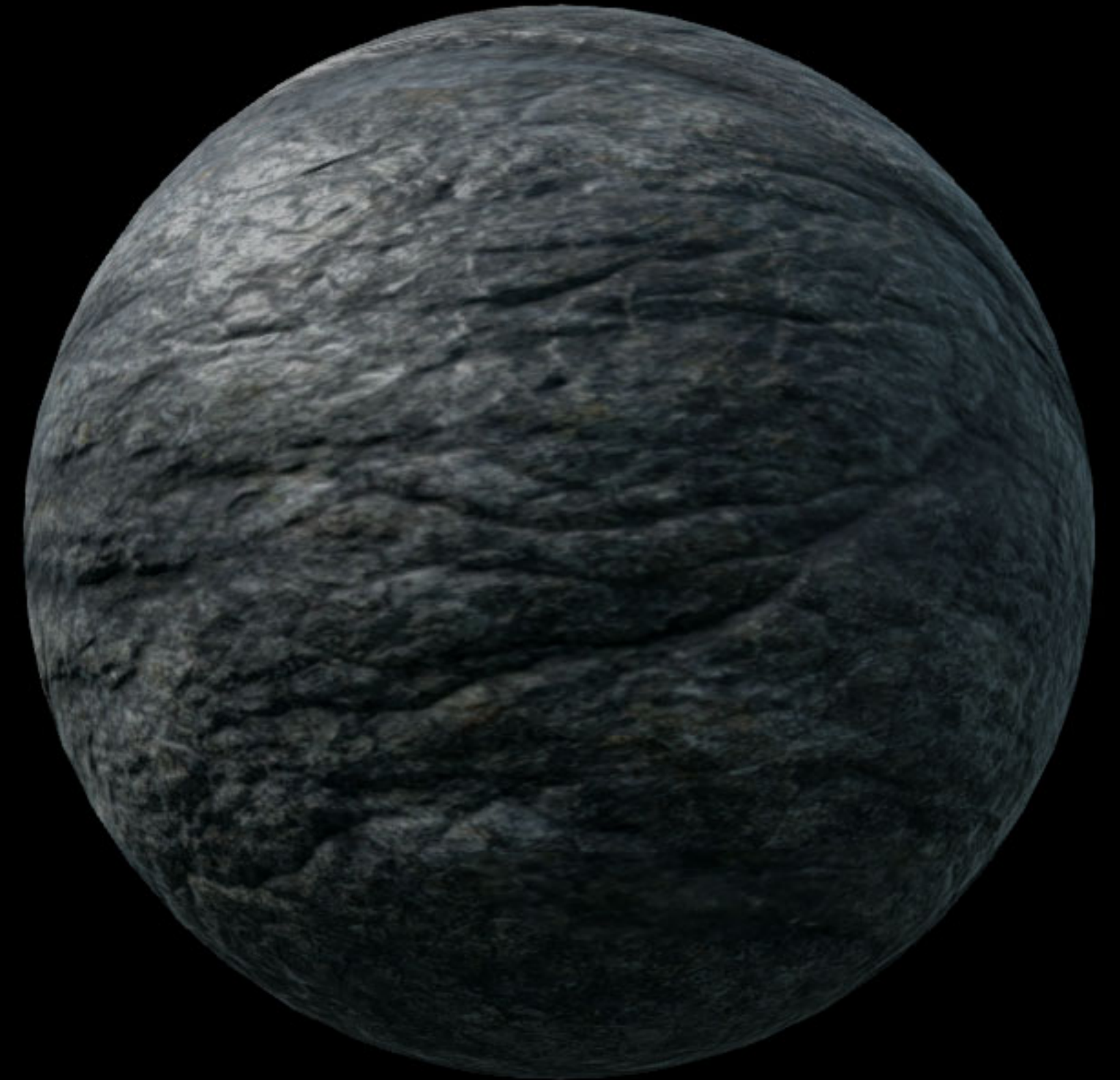
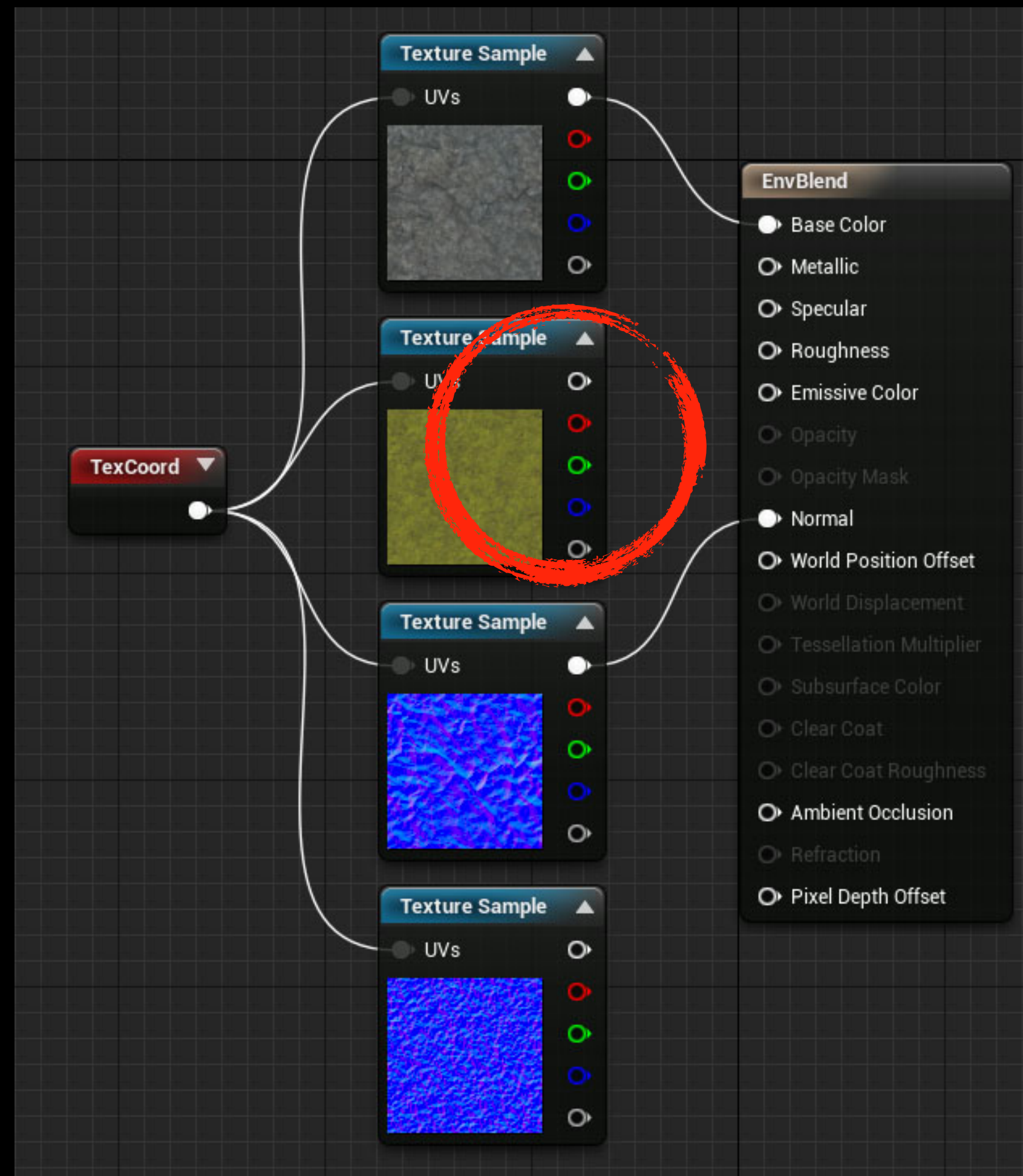
Environment Blending Example



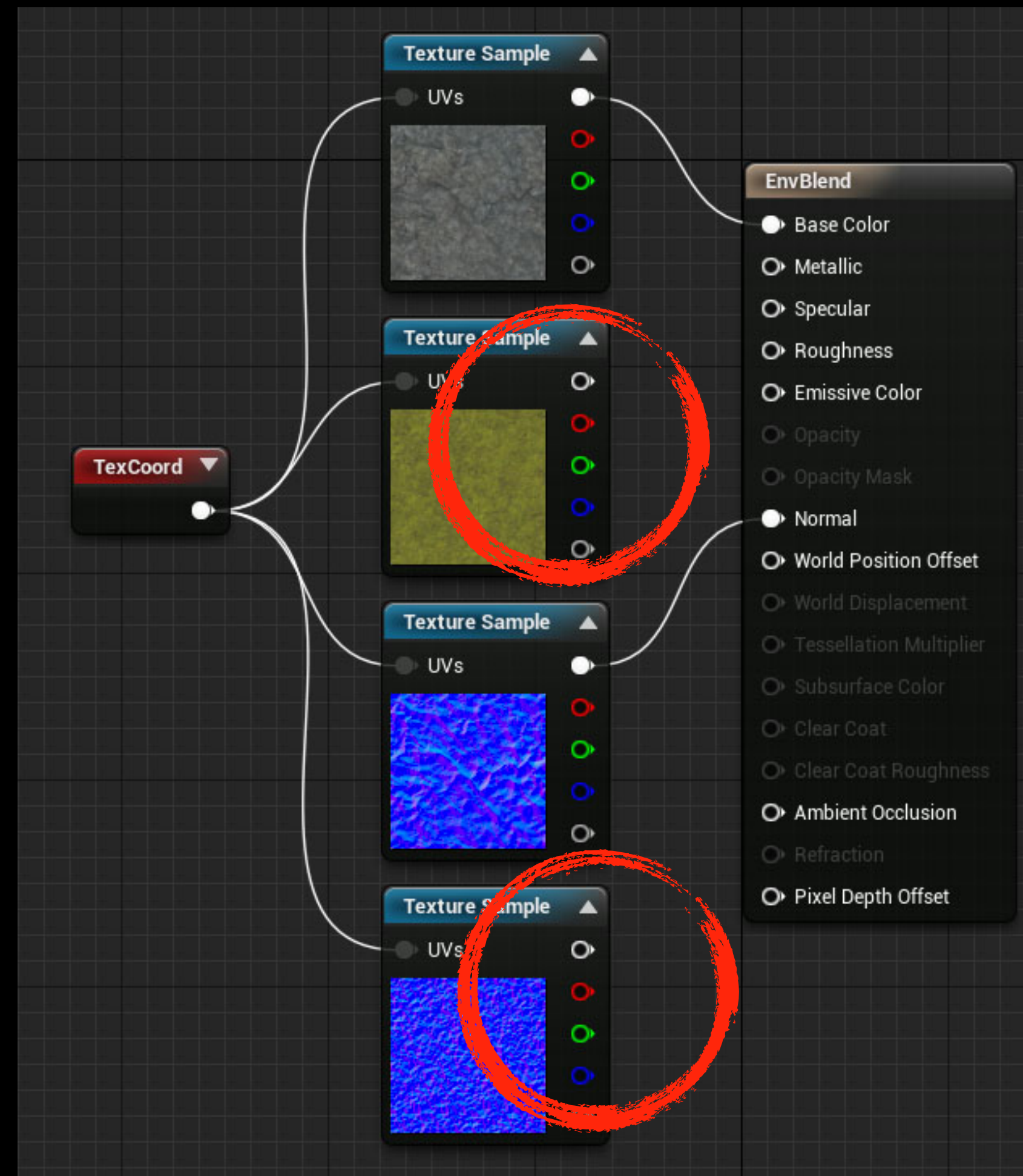
Need to Mix Textures



Need to Mix Textures



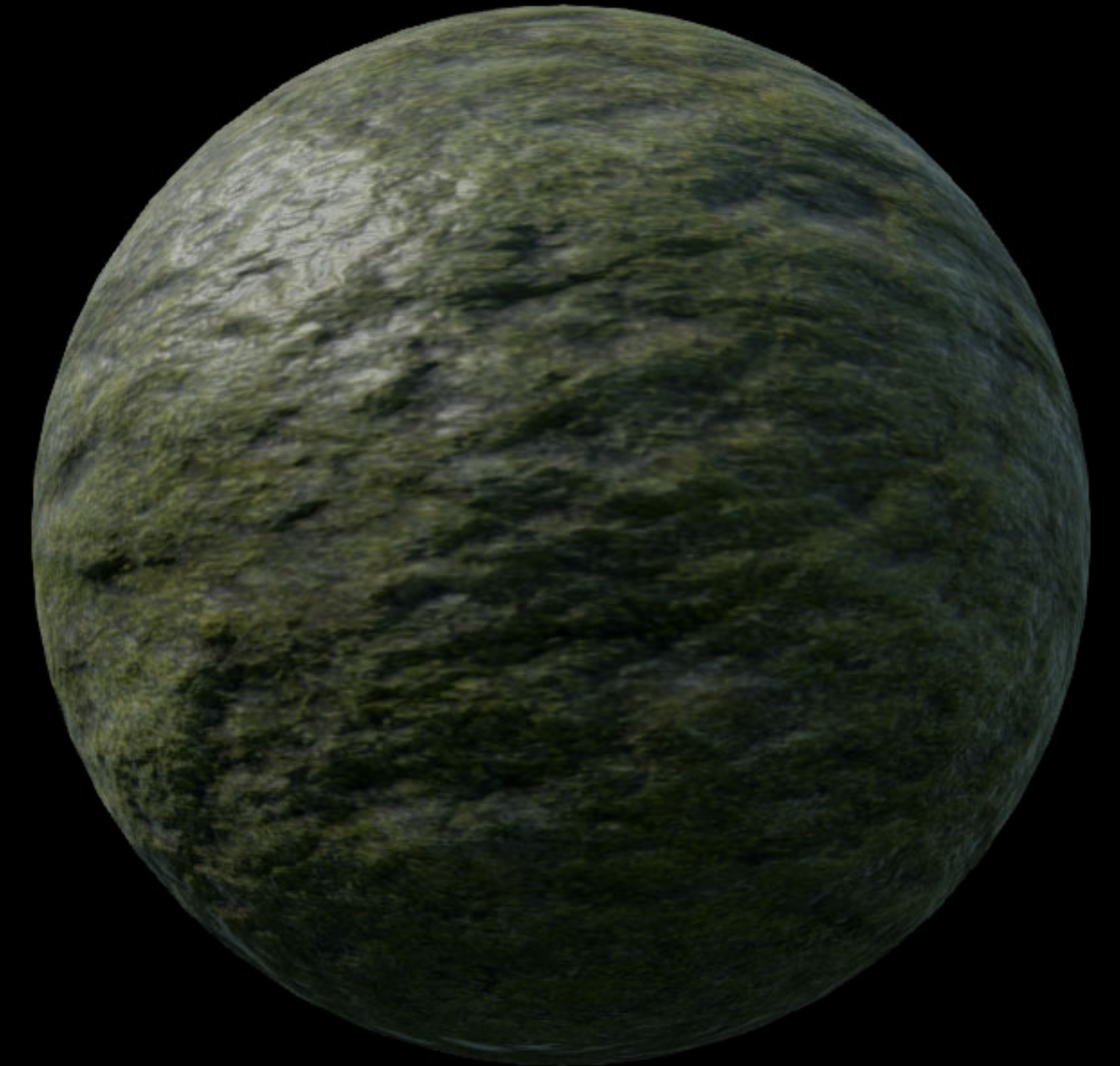
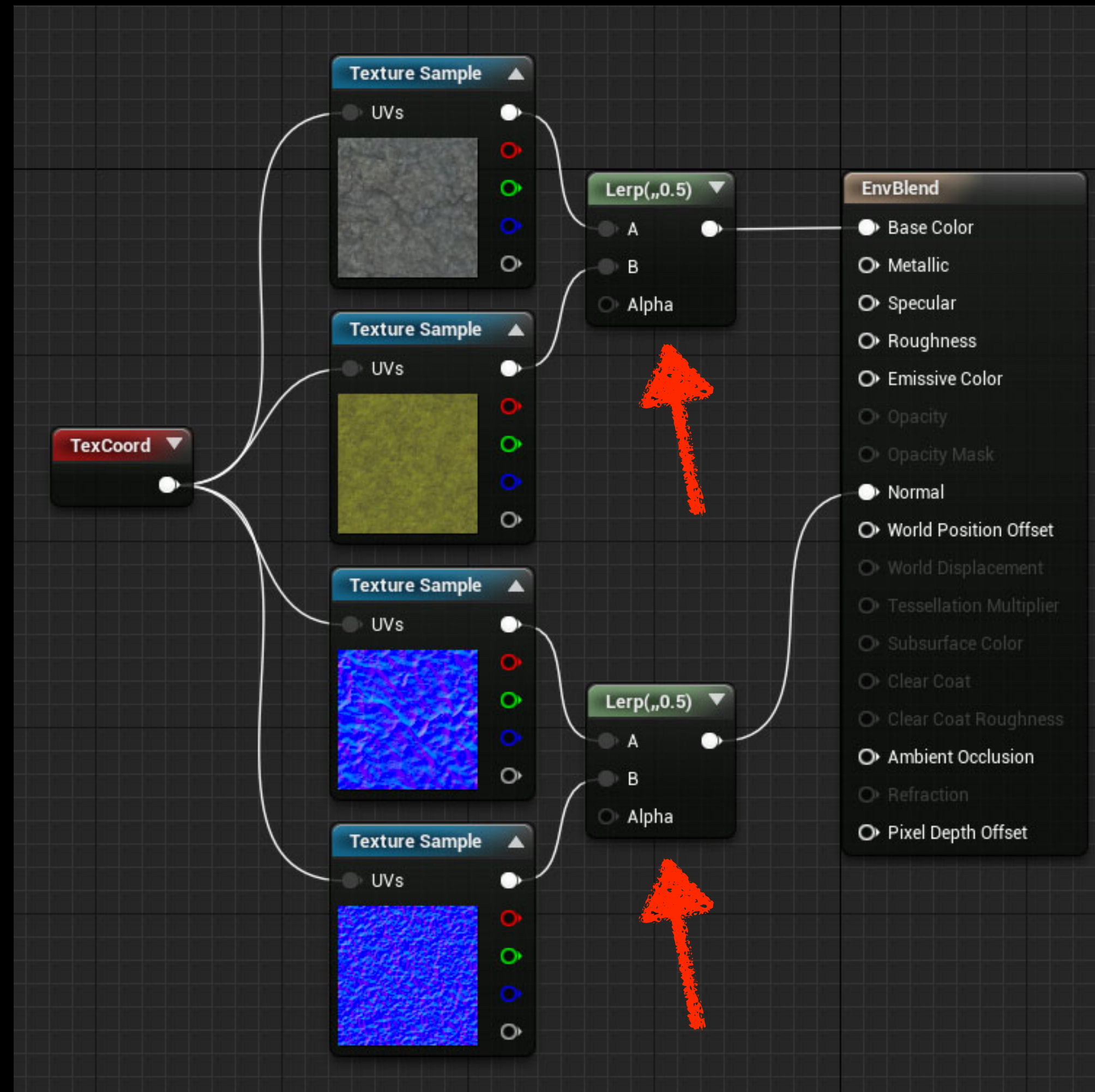
Need to Mix Textures



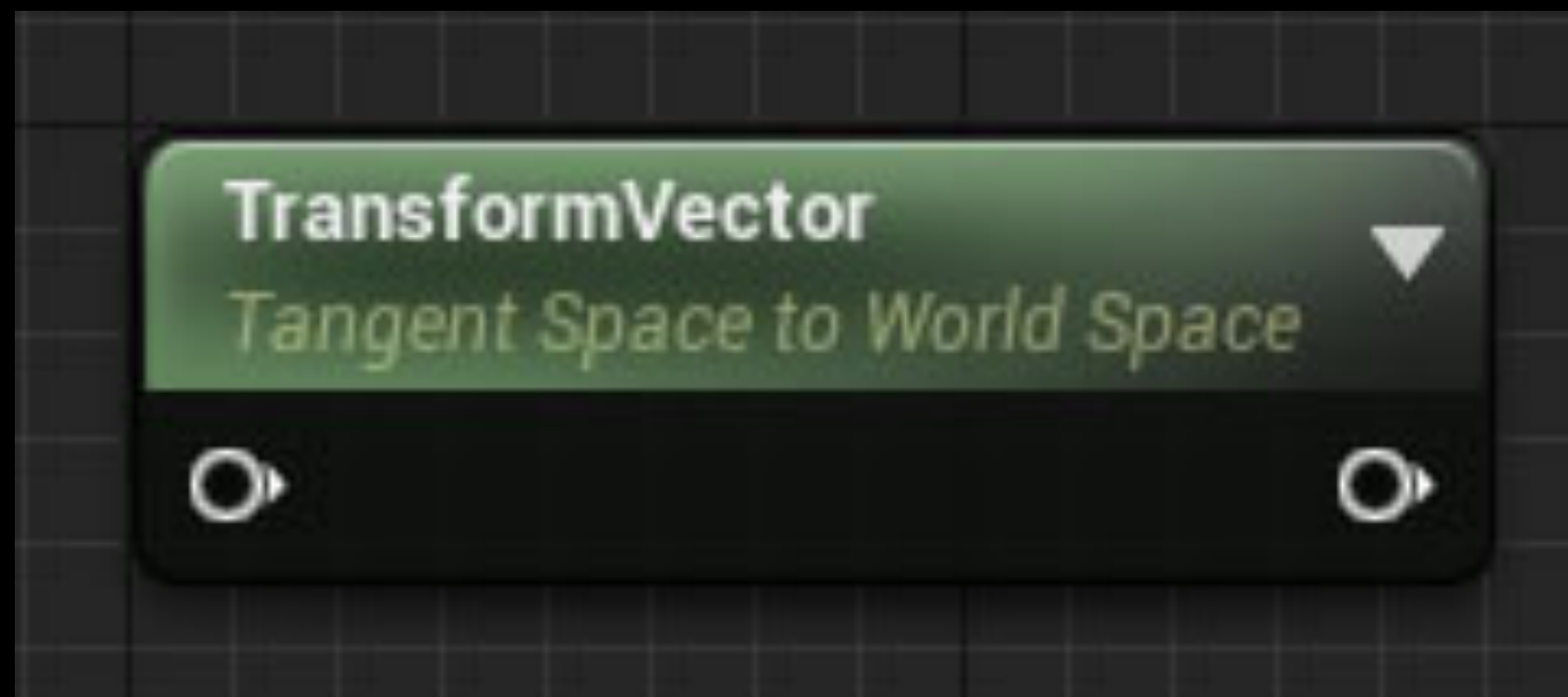
Lerp



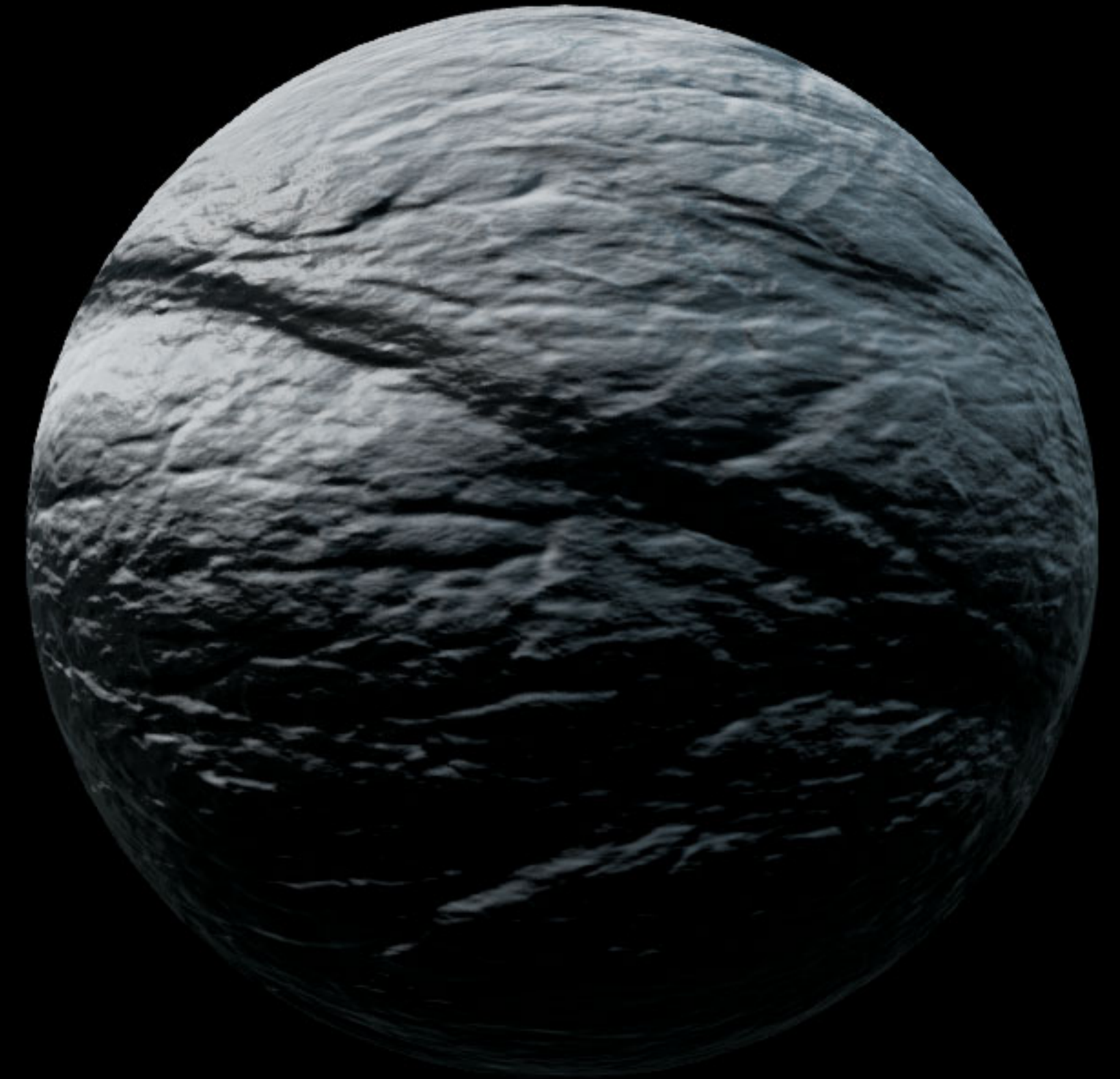
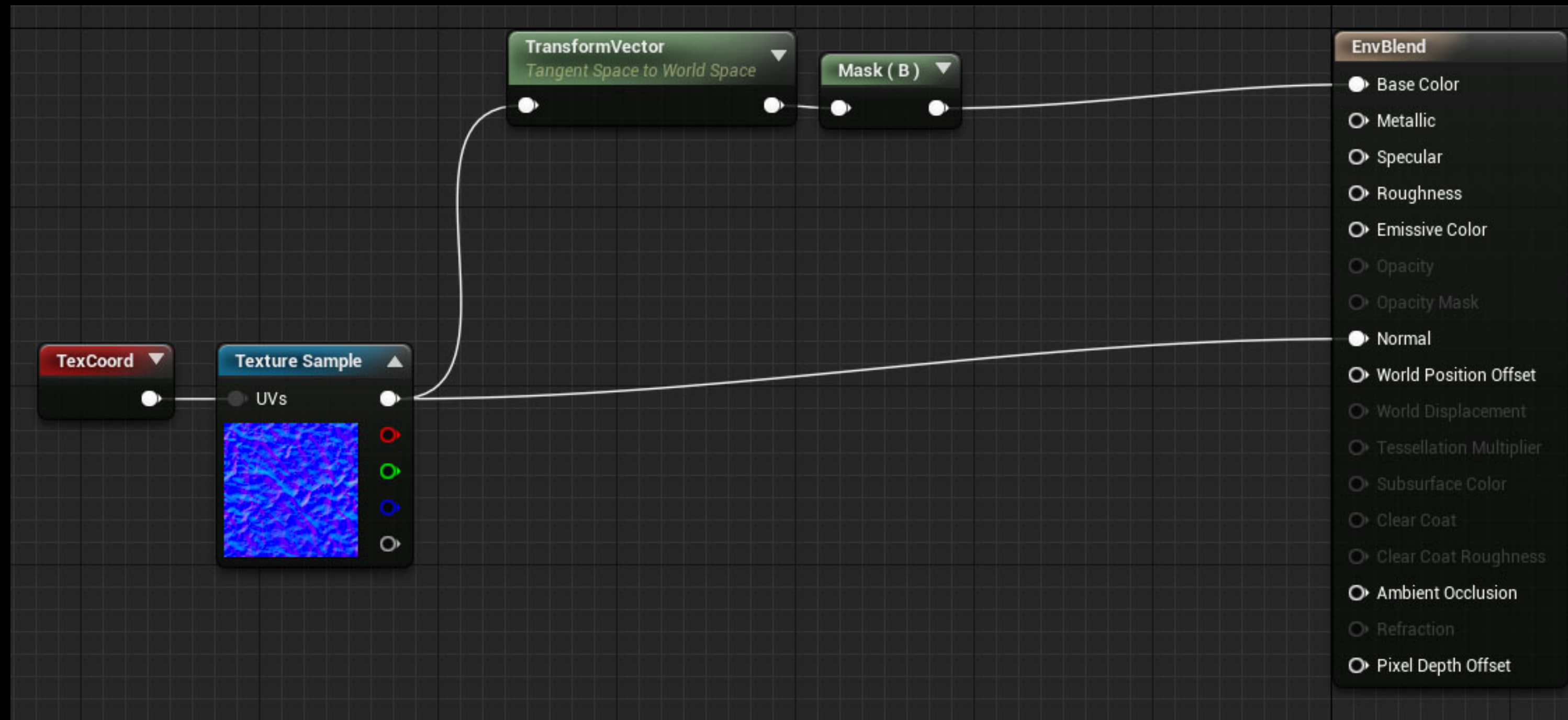
50/50 Mix



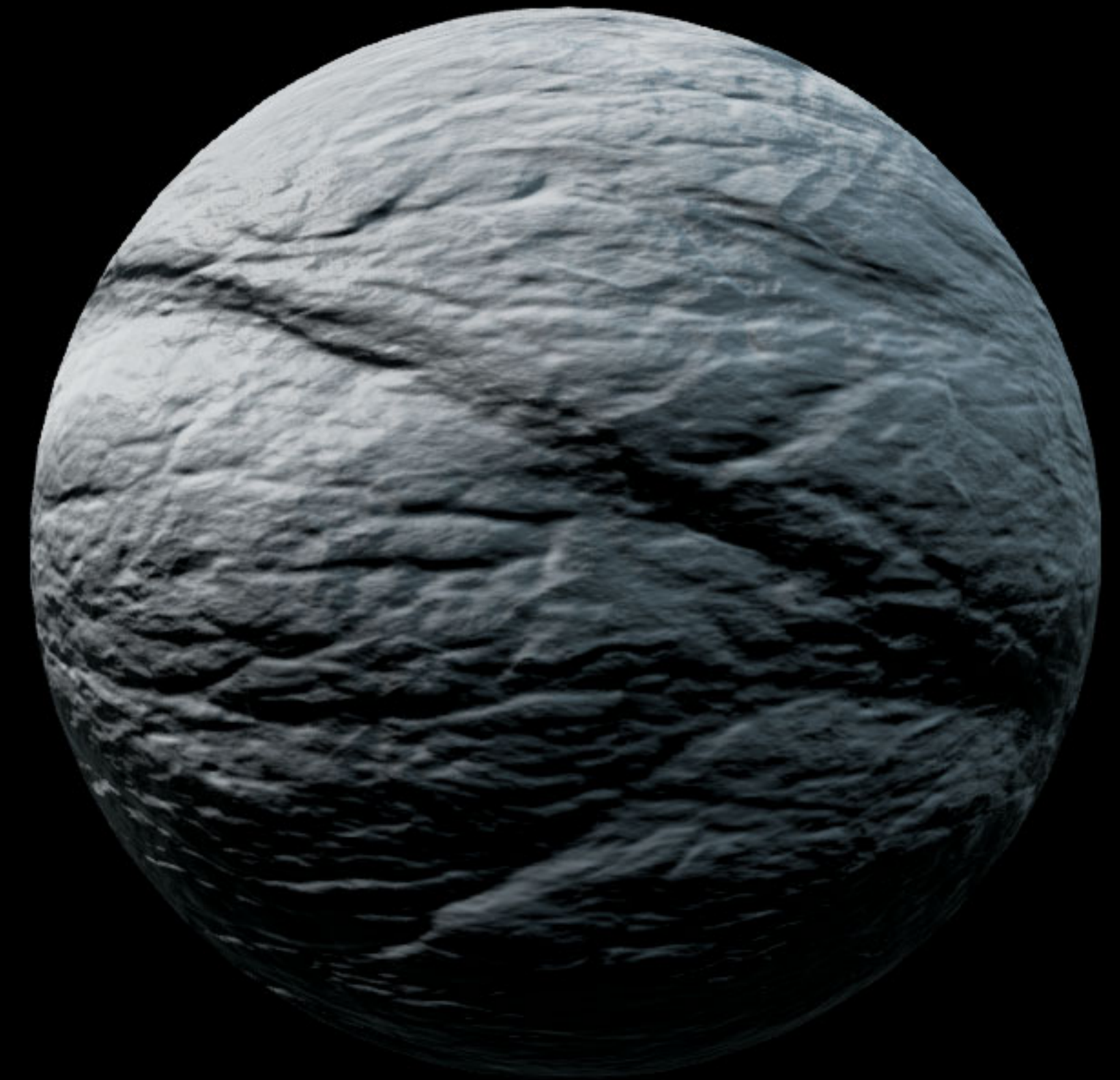
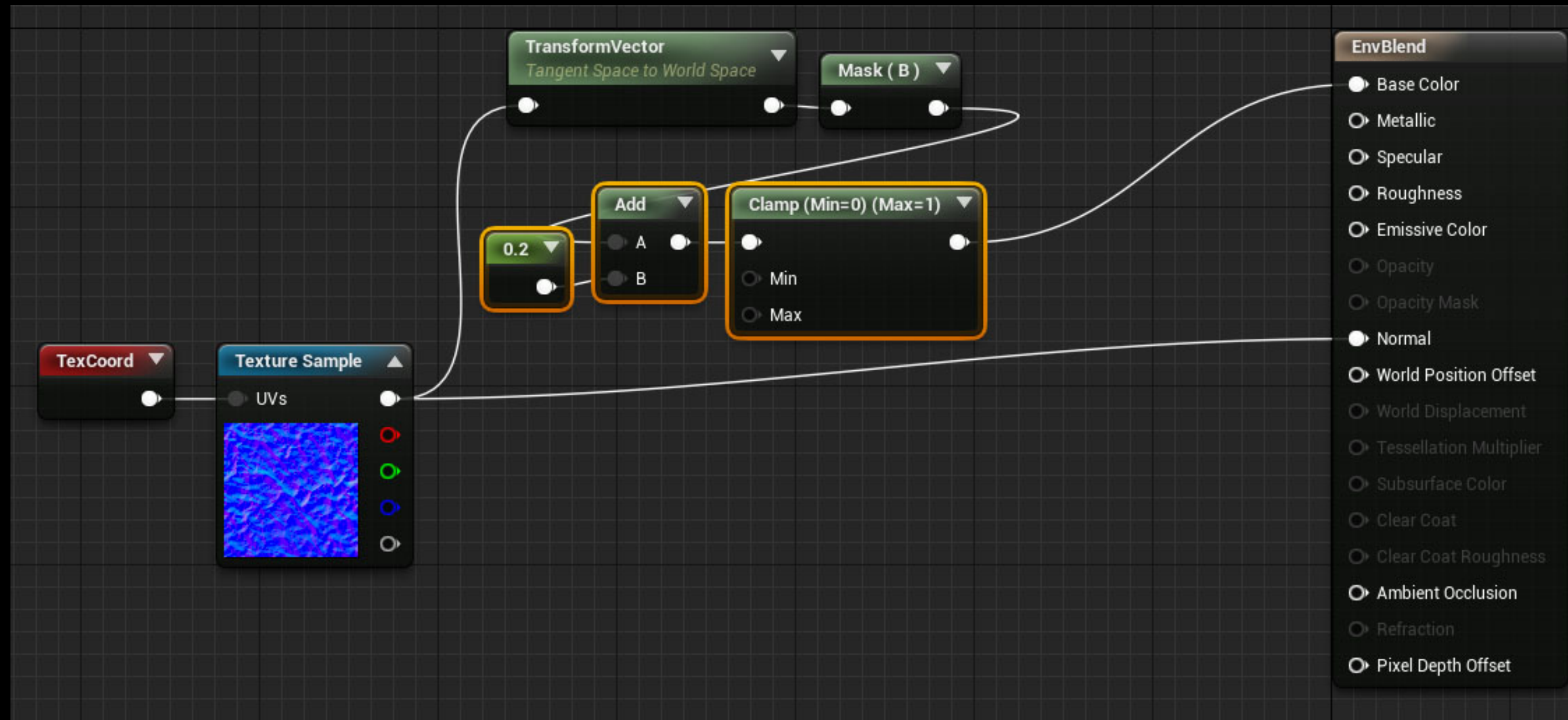
Transform & Mask



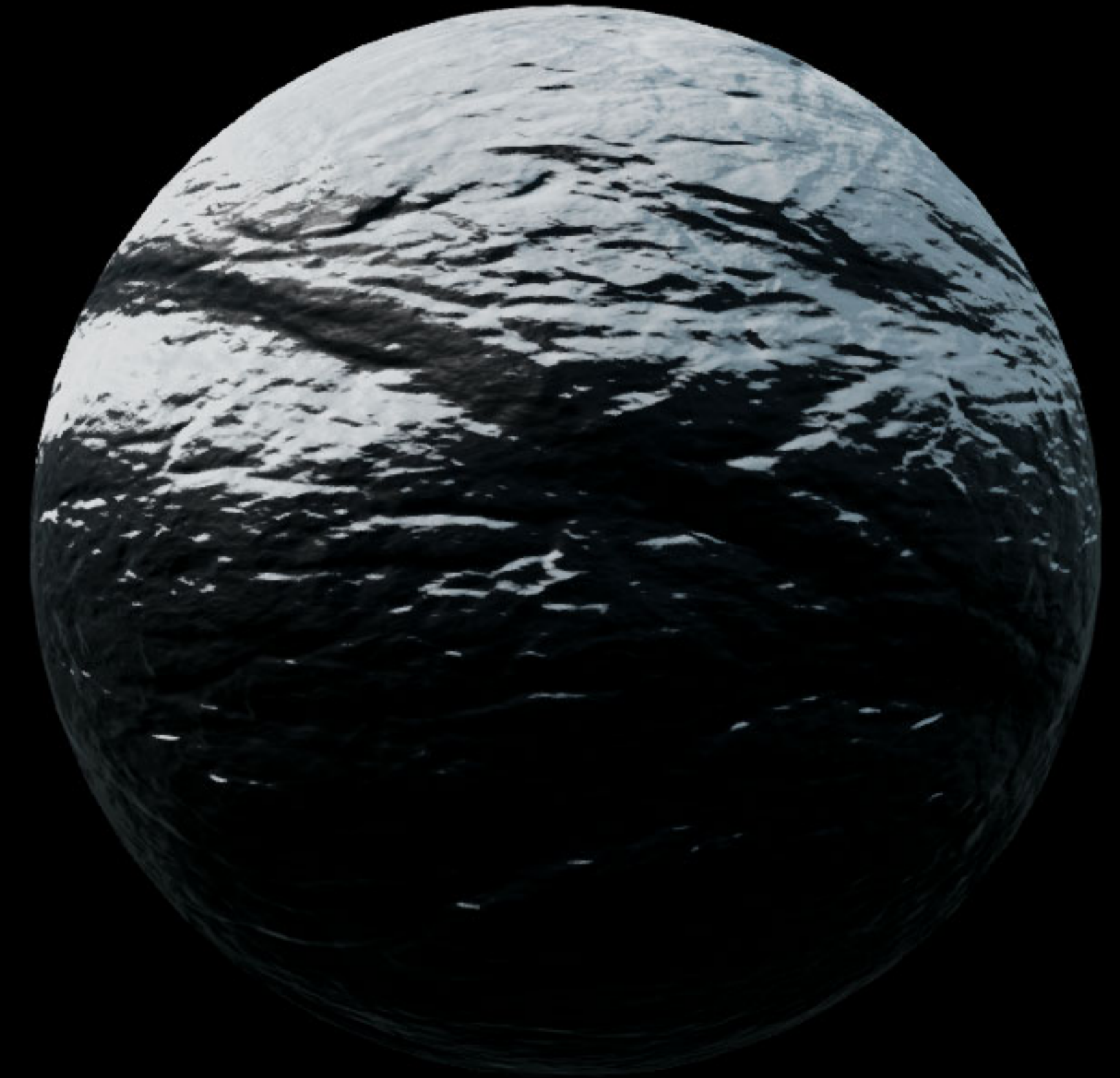
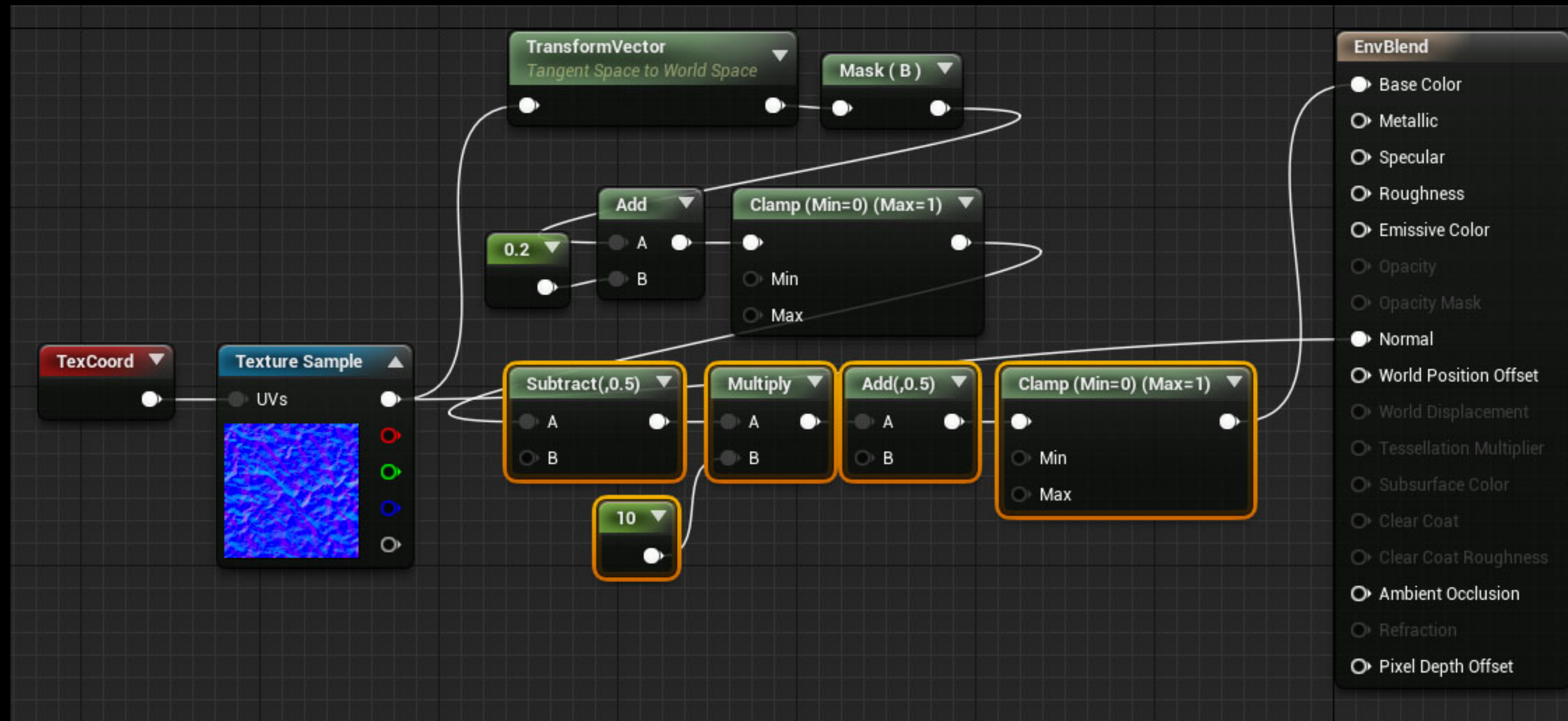
Use World Y As Mask



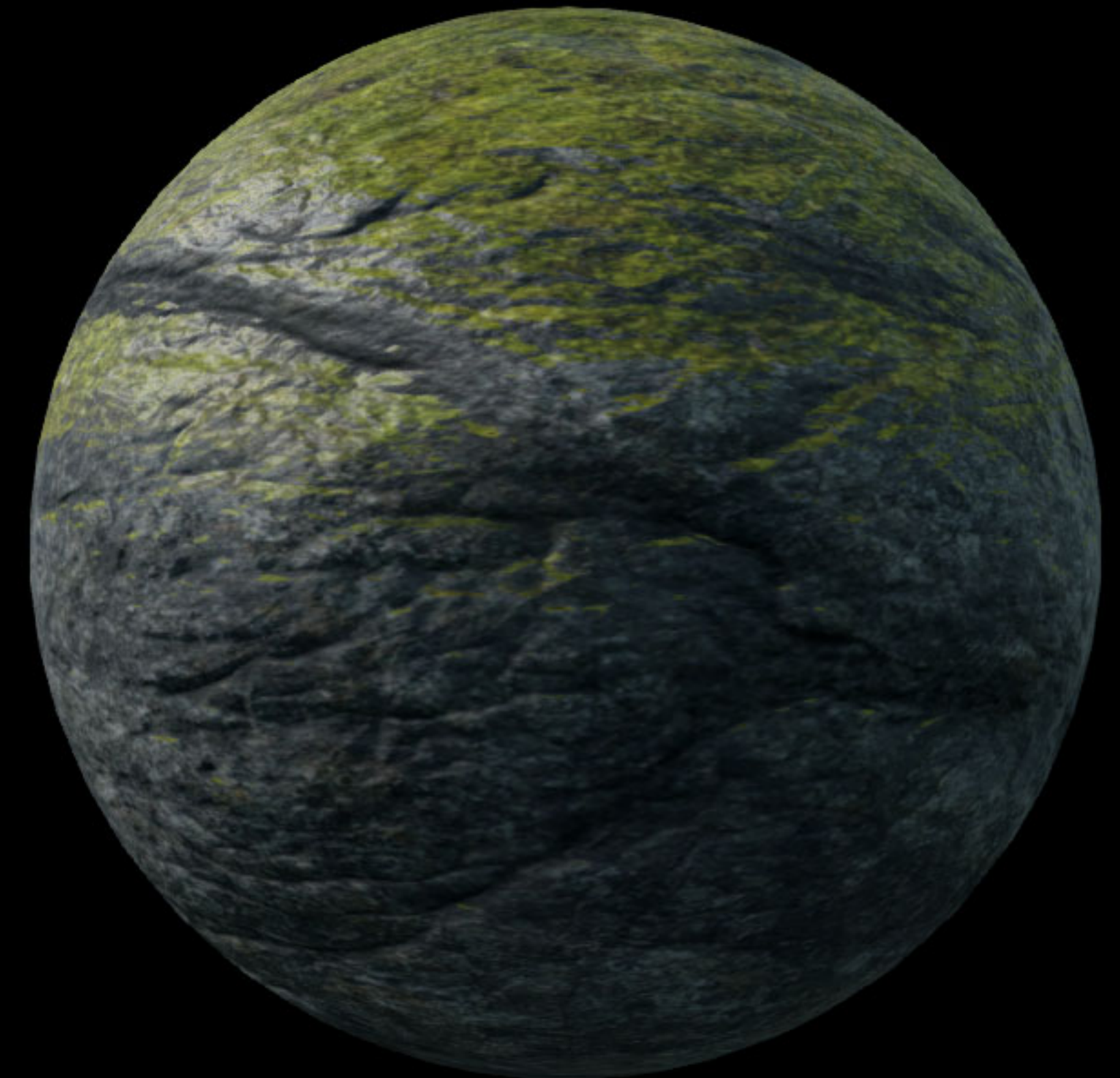
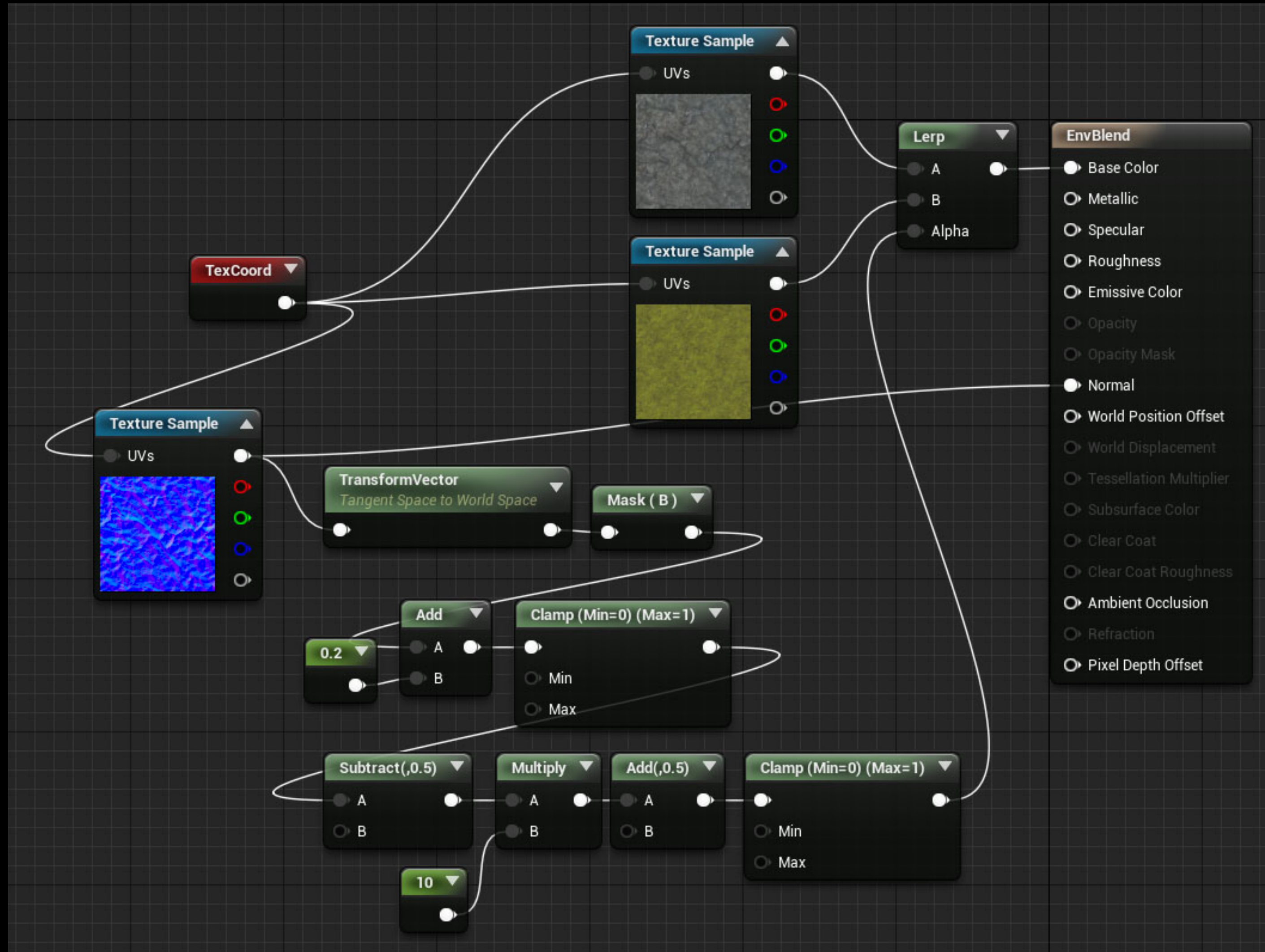
Adjust the Mask



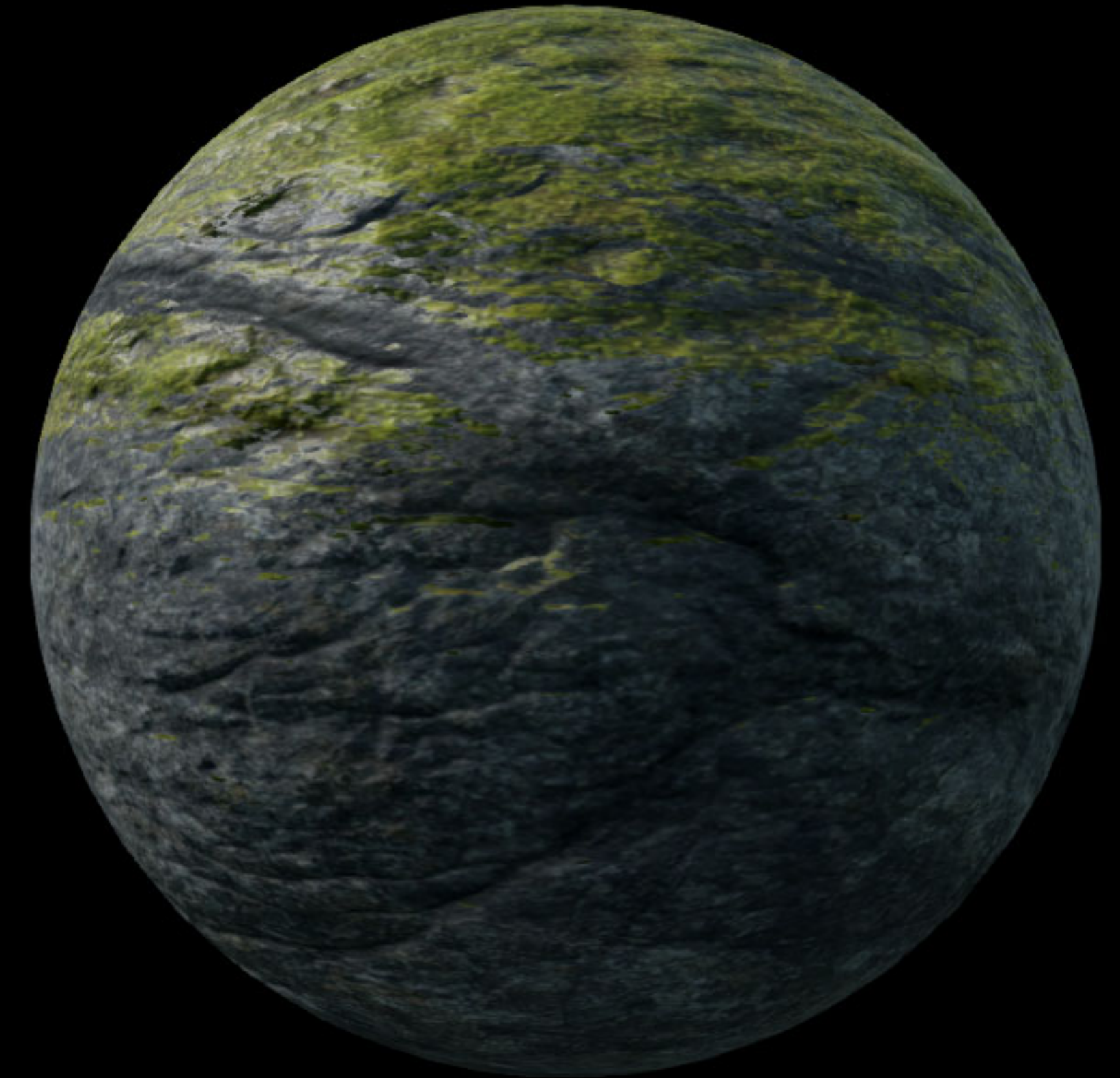
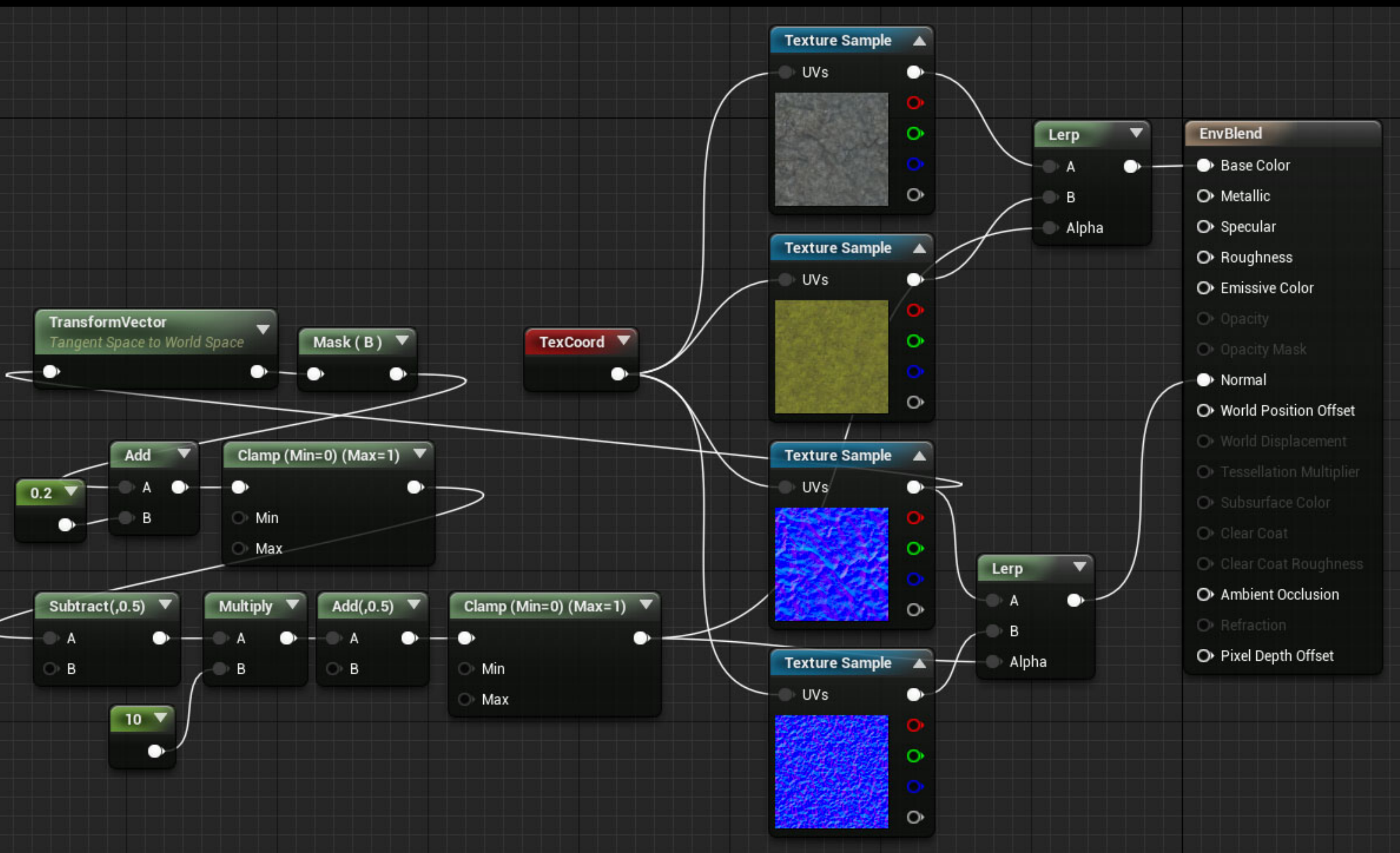
Sharpen the Mask



Mix Textures With the Mask



Final Shader



Environment Blend Shader Code

```
float environmentMask(float3 worldSpaceNormal)
{
    float worldSpaceY = saturate(worldSpaceNormal.y + 0.2);
    float sharpenedMask = saturate(((worldSpaceY - 0.5) * 10) + 0.5);
    return sharpenedMask;
}
```

Next Steps

- Study what other games are doing
- Grab a book
- Google and YouTube Search
- Download Unreal or use ShaderFX in Max or Maya
- Write shaders!

Thanks!