



FALMOUTH
UNIVERSITY



COMP280: Specialisms in Creative Computing

10: Geometry

Learning outcomes

- ▶ **Understand** how a mesh is represented in memory
- ▶ **Implement** custom meshes in UE4 or Unity
- ▶ **Manipulate** these meshes in a shader

Intro

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- ▶ You need to understand how this data is represented in memory
- ▶ Add how to operate on the data in shaders to achieve certain effects

Meshes



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- ▶ We can also create custom meshes in code e.g. Procedural Mesh in UE4 or Mesh Class in Unity
- ▶ Creating meshes in code are useful for certain effects and visual debugging

Vertices



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- ▶ You must provide this x, y, z or the vertex shader will not run

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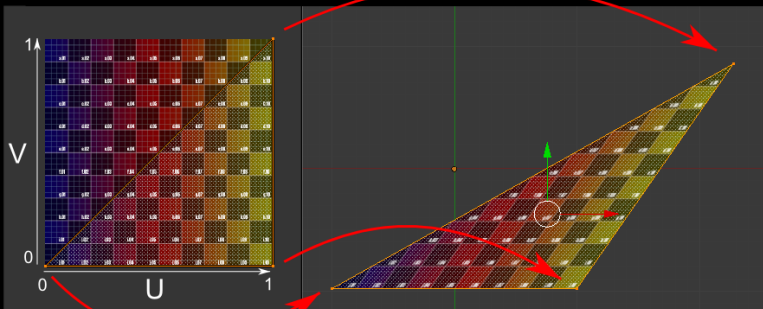
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- ▶ (So really just another name for xy coordinates in texture space)

UV coordinates



Normals

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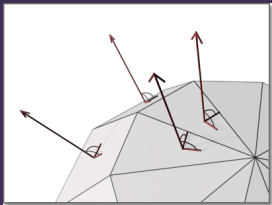
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- ▶ You can use the dot product of this normal and the light direction, to work out how much light is cast on the surface

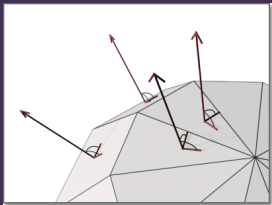
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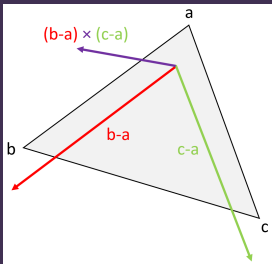
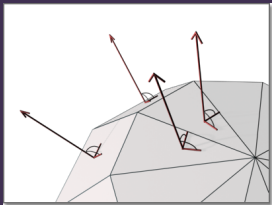
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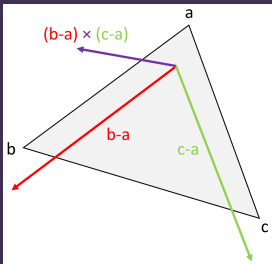
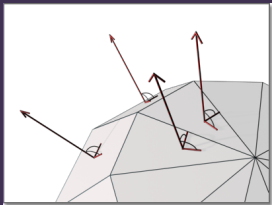
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- ▶ So the normal is

$$\frac{n}{|n|} \quad \text{where} \quad n = (b - a) \times (c - a)$$

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- ▶ You could use the vertex colours to hold target positions for animations

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- ▶ A cube would have 36 vertices, this will be at least 432 bytes (12 bytes per vertex)
- ▶ With indices, we used 8 vertices and 36 indices, which is around 240 bytes in total.

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Vertex Shader



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- ▶ <https://docs.unity3d.com/Manual/SL-VertexProgramInputs.html>

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 - ▶ Vector Expressions: <https://docs.unrealengine.com/en-US/Engine/Rendering/Materials/ExpressionReference/Vector/index.html>
 - ▶ Coordinate Expressions:
<https://docs.unrealengine.com/en-US/Engine/Rendering/Materials/ExpressionReference/Coordinates/index.html>

Vertex Shader - GLSL Example

```
#version 330 core

layout(location = 0) in vec3 vertexPosition;
layout(location = 1) in vec2 vertexTextureCoord;

uniform mat4 modelMatrix;
uniform mat4 viewMatrix;
uniform mat4 projectionMatrix;

out vec2 vertexTextureCoordOut;

void main(){

    mat4 mvpMatrix=projectionMatrix*viewMatrix*modelMatrix;

    vec4 mvpPosition=mvpMatrix*vec4(vertexPosition,1.0f);

    vertexTextureCoordOut=vertexTextureCoord;

    gl_Position=mvpPosition;
}
```

Fragment Shader



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- ▶ Typically used for shading calculations and texturing

Fragment Shader - GLSL Example

```
#version 330 core

in vec2 vertexTextureCoordOut;

out vec4 colour;

uniform sampler2D diffuseTexture;

void main()
{
    colour=texture2D(diffuseTexture ,vertexTextureCoordOut);
}
```

Meshes Example



Unity3D - Meshes

- ▶ Mesh Class - <https://docs.unity3d.com/ScriptReference/Mesh.html>

UE4 - Meshes

- ▶ Procedural Mesh Blueprints - <https://docs.unrealengine.com/en-US/BlueprintAPI/Components/ProceduralMesh/index.html>
<https://www.youtube.com/watch?v=dKlMEmVgbvg>
- ▶ Procedural Mesh C++ - <http://wlosok.cz/procedural-mesh-in-ue4-1-triangle/>