GAM250: Advanced Games Programming

4: Graphics Programming

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Learning outcomes

- **Understand** the modern Programmable Graphics Pipeline
- **Understand** Unity's Material System
- **Write** Subsurface and Image Processing Shaders in Unity

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The Graphics Pipeline

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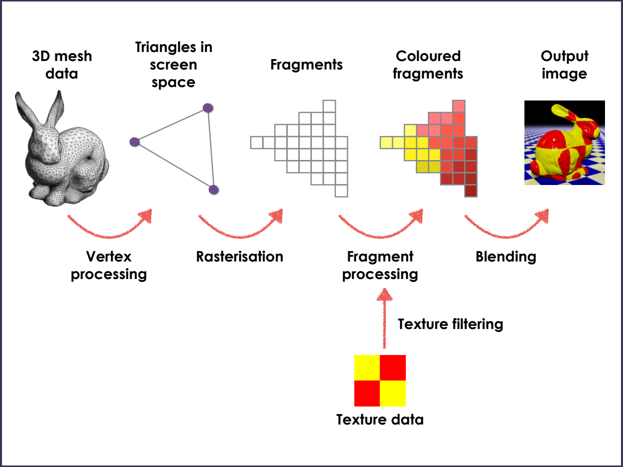
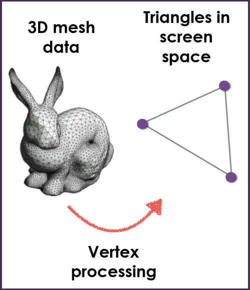
The 3D graphics pipeline



Vertex processing



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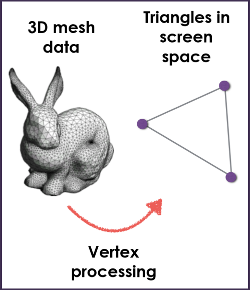

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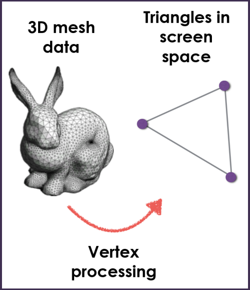

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- Each triangle has three **vertices** specified in 3D space (x, y, z)

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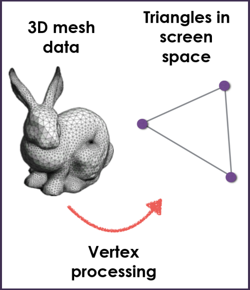

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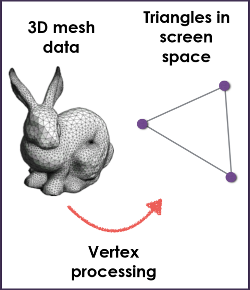

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- Each triangle has three **vertices** specified in 3D space (x, y, z)
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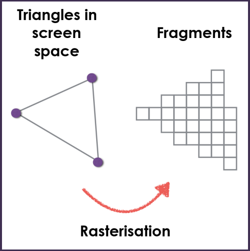
- May also apply particle simulations, skeletal animations or deformations, etc.

Rasterisation



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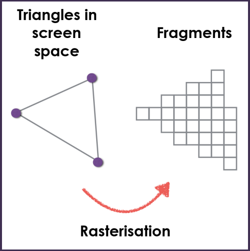

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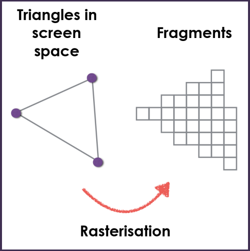
Rasterisation



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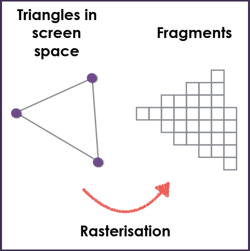

- Determine **which fragments** are covered by the triangle
- In practical terms, “fragment” = “pixel”
- Vertex processor can associate **data** with each vertex; this is **interpolated** across the fragments

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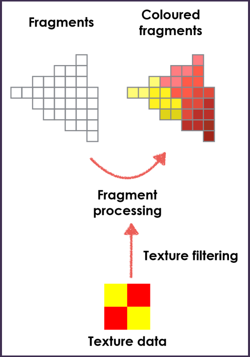
Fragment processing



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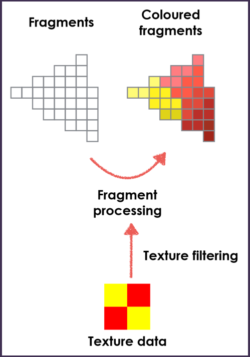
Fragment processing



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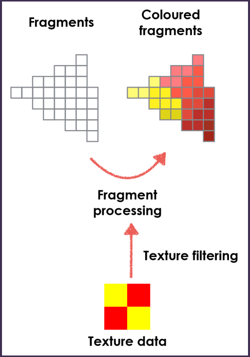

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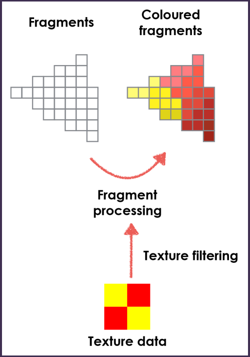
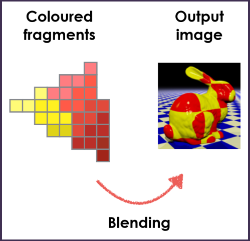


- Determine the **colour** of each fragment covered by the triangle
- **Textures** are 2D images that can be **wrapped** onto a 3D object
- Colour is calculated based on **texture**, **lighting** and other properties of the surface being rendered (e.g. shininess, roughness)

Blending



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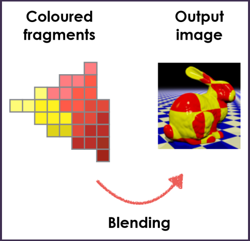

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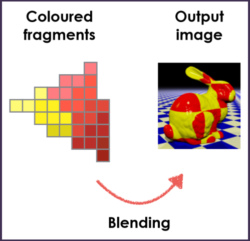

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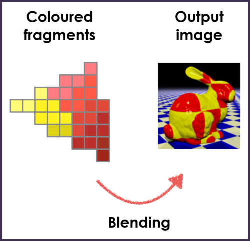

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- **Depth testing**: if the new fragment is "in front" of the old one, replace it; if it is "behind", discard it
- **Alpha blending**: combine the old and new colours for a semi-transparent appearance

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- Programs for these units are called **shaders**
- **Vertex shader**: responsible for geometric transformations, deformations, and projection
- **Fragment shader**: responsible for the visual appearance of the surface
- Vertex shader and fragment shader are separate programs, but the vertex shader can pass arbitrary values through to the fragment shader

Further Reading

- Game Programming Patterns - `http://gameprogrammingpatterns.com/contents.html`
- Game Programming Patterns in Unity - `http://www.habrador.com/tutorials/programming-patterns/`
- Unity Design Patterns - `https://github.com/Naphier/unity-design-patterns`