COMP220: Graphics & Simulation

1: The graphics pipeline

Learning outcomes

By the end of today's session, you will be able to:

- **Recall** the key stages of the graphics pipeline
- **Explain** the differences between a CPU and a GPU
- **Write** basic programs using SDL and OpenGL

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Course introduction

From the module guide

This module will introduce you to the techniques of 3D graphics rendering and physics simulation used in modern computer games. Using the OpenGL library, you will develop an understanding of the 3D graphics pipeline, and how to program the GPU to produce advanced graphical effects.

Topic schedule

On LearningSpace...

Assignment 1: Portfolio task

First worksheet is due in week 4.

Assignment 2: Research journal

First component due in week 3.

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Graphics and simulation hardware

CPUs vs GPUs

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  - Optimised for performing the same calculation on several thousand vertices or pixels at once

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- Deep learning

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- On this module we will use **OpenGL** (but the principles are transferable)

The 3D graphics pipeline

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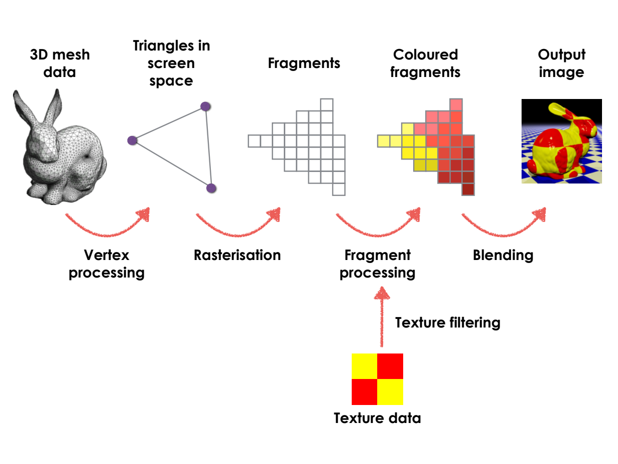
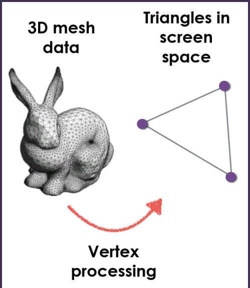


Vertex processing



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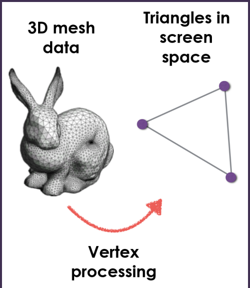

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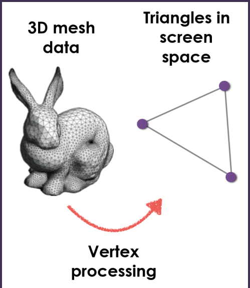

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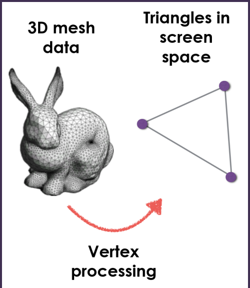

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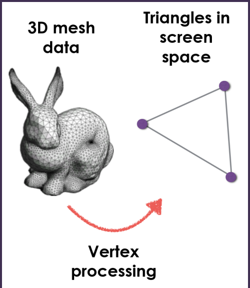

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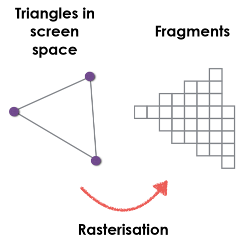
- May also apply particle simulations, skeletal animations or deformations, etc.

Rasterisation



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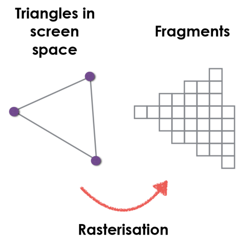

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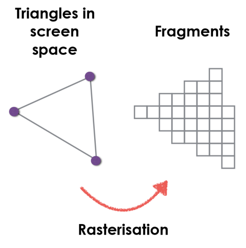

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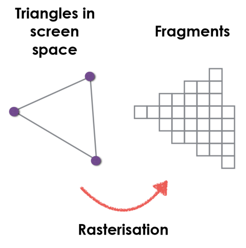

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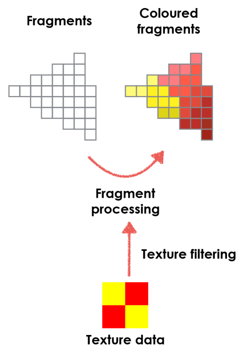
- In practical terms, “fragment” = “pixel”
- Vertex processor can associate **data** with each vertex; this is **interpolated** across the fragments

Fragment processing



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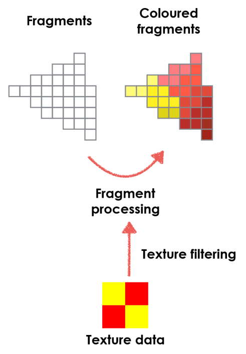

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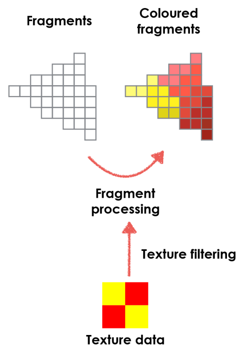

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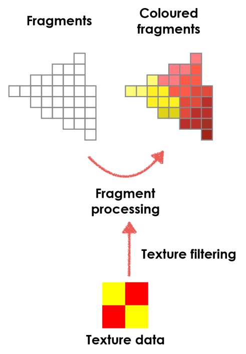
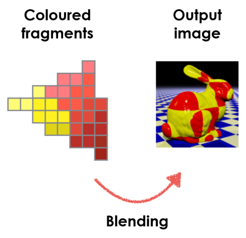


- Determine the **colour** of each fragment covered by the triangle
- **Textures** are 2D images that can be **wrapped** onto a 3D object
- Colour is calculated based on **texture**, **lighting** and other properties of the surface being rendered (e.g. shininess, roughness)

Blending



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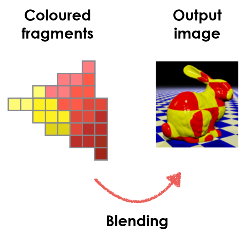

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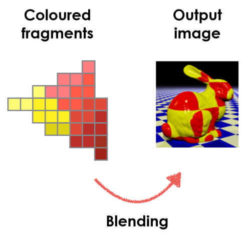

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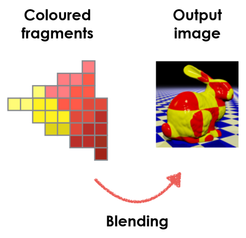

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- **Depth testing**: if the new fragment is "in front" of the old one, replace it; if it is "behind", discard it
- **Alpha blending**: combine the old and new colours for a semi-transparent appearance

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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

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Your first OpenGL program

SDL and OpenGL

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- We will use **SDL** (which you have used before in COMP140)

Live coding

https://github.com/Falmouth-Games-Academy/comp220-code-examples

Live coding - basics

http://headerphile.com/sdl2/opengl-part-1-sdl-opengl-awesome/

Our first triangle

http://www.opengl-tutorial.org/beginners-tutorials/tutorial-2-the-first-triangle/

Debrief

It's the end of today's session. You are now able to:

- **Recall** the key stages of the graphics pipeline
- **Explain** the differences between a CPU and a GPU
- **Write** basic programs using SDL and OpenGL