OpenGL and GLSL

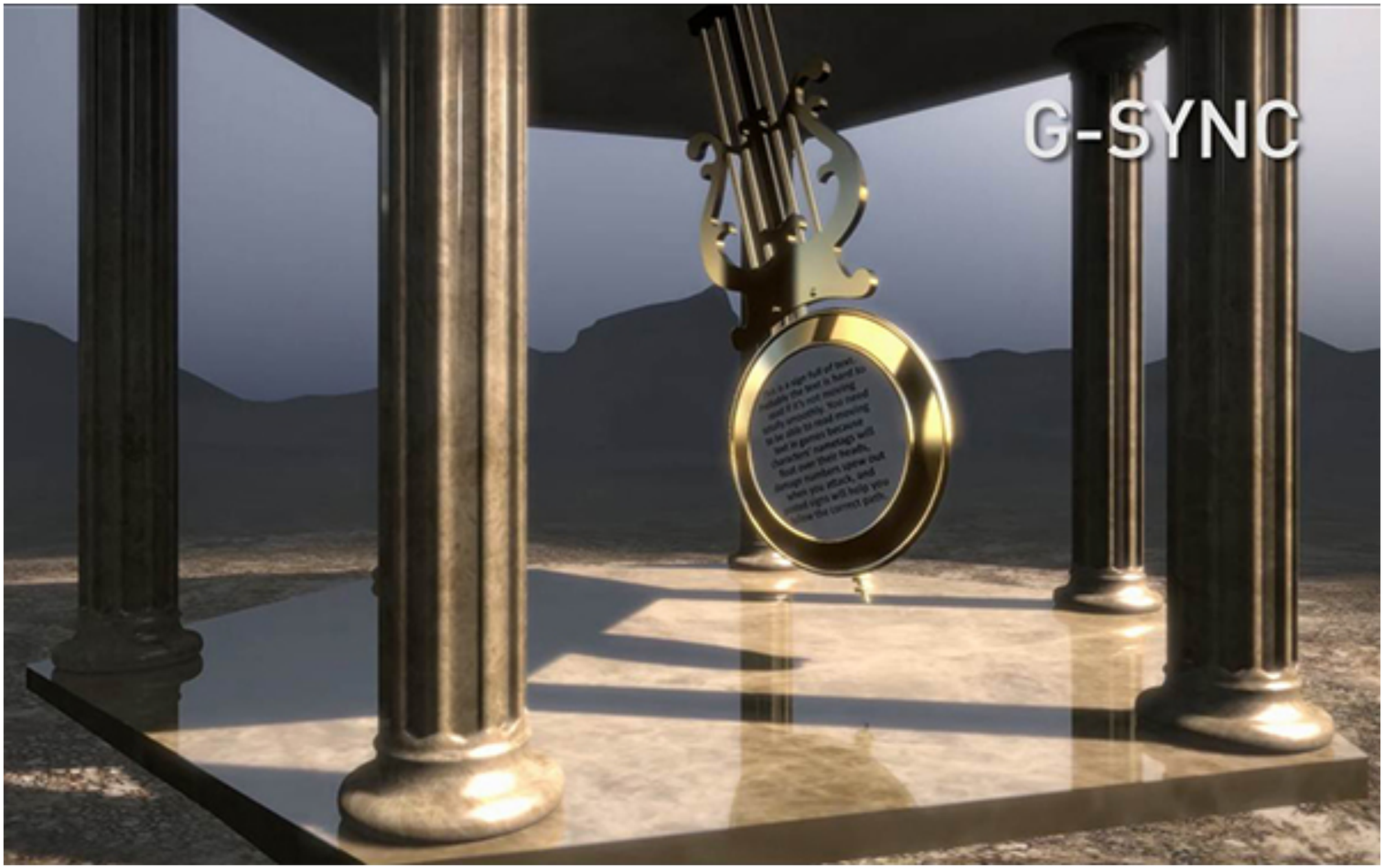
CS 4620 Lecture 14

with slides from Nicolas Savva

OpenGL 25 years ago

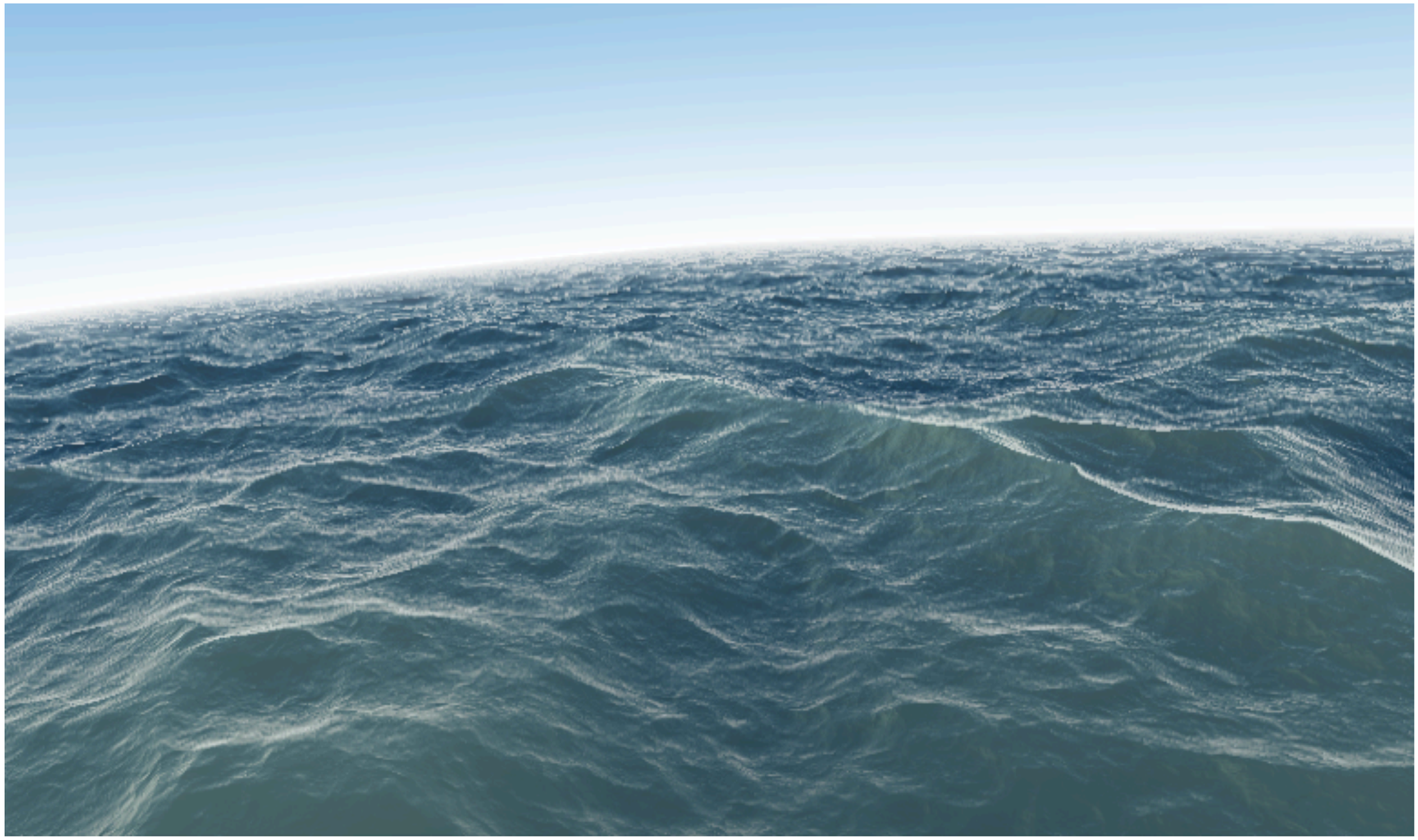
Modern OpenGL

(OK, this is rendered with DirectX, but you get the idea)



NVIDIA demo https://www.youtube.com/watch?v=s6T9jlwQBSM

Modern WebGL



"Seascape" by Alexander Alekseev

Sources for more examples:
http://glslsandbox.com
http://shadertoy.com

What changed?

25 years ago:

- Vertex transformation/fragment shading hardcoded into GPUs

Now:

- More parts of the GPU are programmable (but not all)

What changed?

25 years ago (Fixed pipeline)**:**

- Transform vertices with modelview/projection matrices
- Shade with Phong lighting model only

Contemporary (Programmable hardware)**:**

- Custom vertex transformation
- Custom lighting model
- More complicated visual effects
- Shadows
- Displaced and detailed surfaces
- Simple reflections and refractions

GLSL

GLSL : **G**raphics **L**ibrary **S**hading **L**anguage

- Syntax similar to C/C++
- Language used to write shaders
  - vertex, tessellation, geometry, fragment, compute
  - We only cover vertex and fragment shaders today
- Based on OpenGL
  - First available in OpenGL 2.0 (2004)
- Alternatives: Nvidia Cg and Microsoft HLSL

What is a Shader Program?

- A small program to control parts of the graphics pipeline
- Consists of 2 (or more) separate parts:
  - Vertex shader controls vertex transformation
  - Fragment shader controls fragment shading

GLSL Program

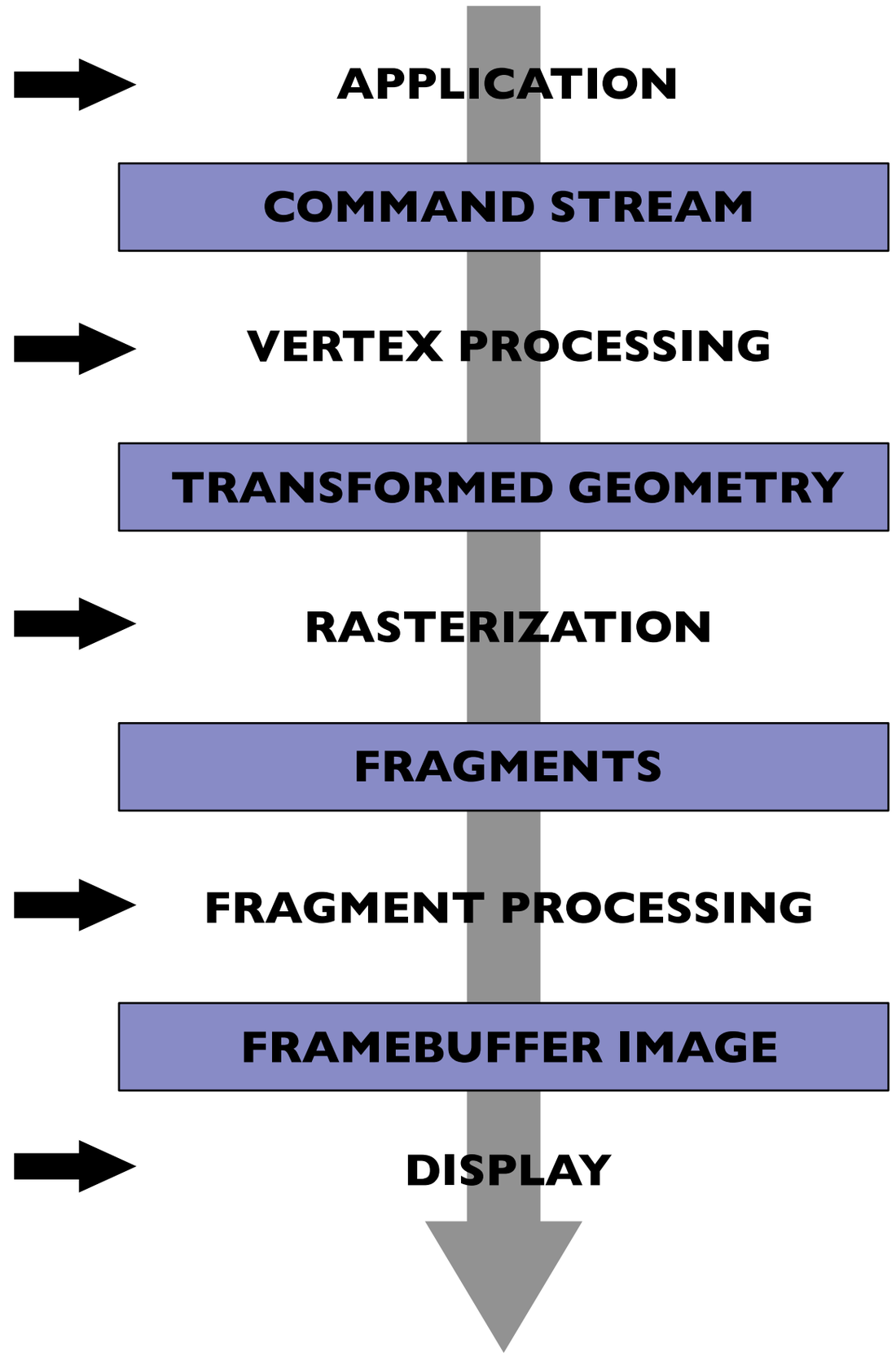
- Specifies how OpenGL should draw geometry

- Program: A collection of shaders that run together
  - At least one vertex shader or one fragment shader

- At any time, the GPU runs only one program
  - Must specify program to use before drawing geometry

Pipeline overview

you are here



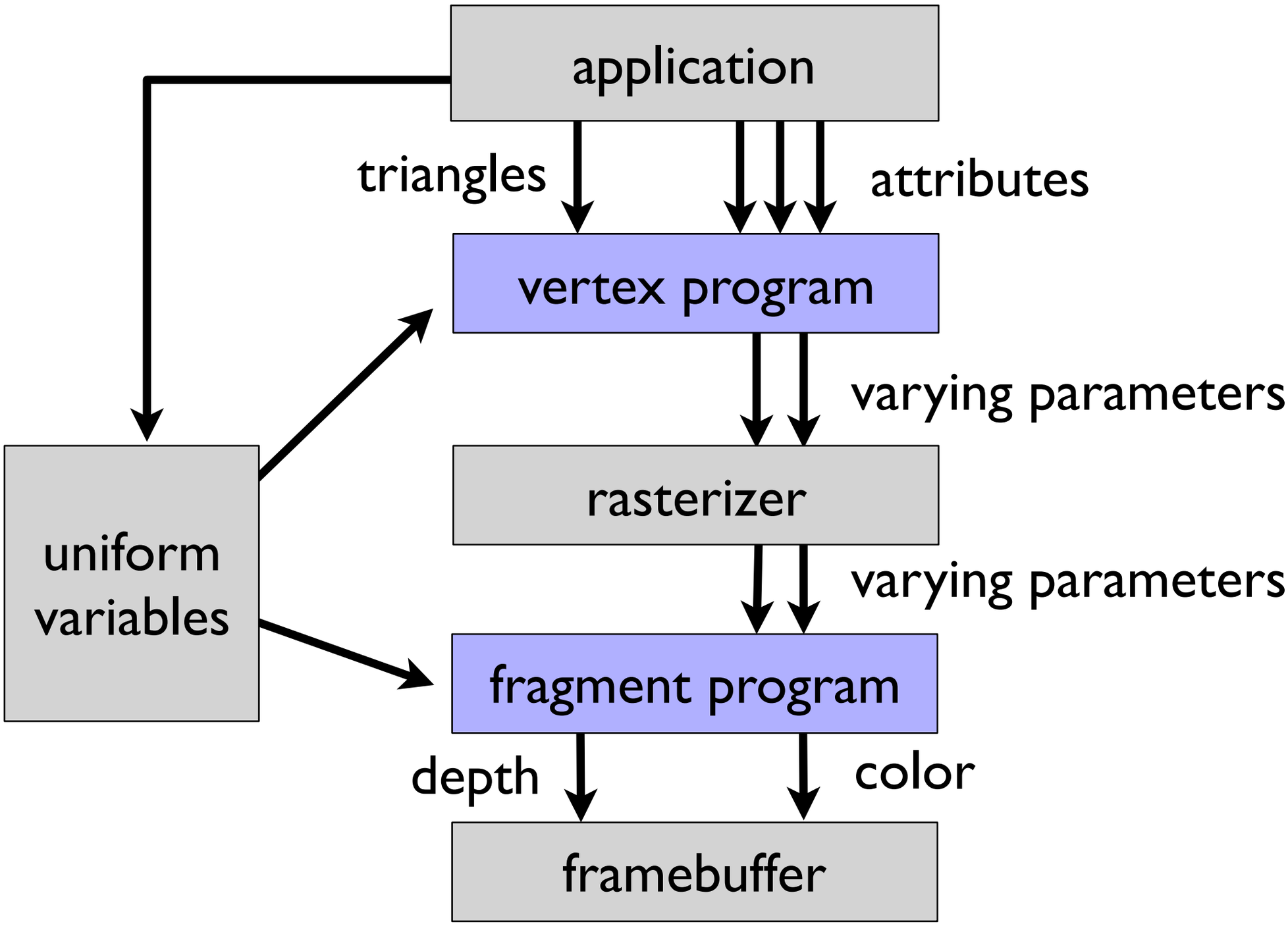
3D transformations; shading

conversion of primitives to pixels

blending, compositing, shading

user sees this

GLSL Shaders



Varieties of OpenGL and GLSL

- **OpenGL versions 1, …, 4.5**
  - for desktop/server GPUs
  - latest features, best performance
- **OpenGL ES 1, …, 3.2**
  - for mobile
  - older, more stable set of features
- **WebGL 1, 2**
  - bindings for OpenGL ES in browser-based JavaScript
  - 1.0 widely supported (OpenGL ES 2); 2.0 (ES 3) in latest browsers
- **GLSL versions 1, …, 4.5**
  - numbers don't always correspond to OpenGL version (later they do)

In this class

- **We will use WebGL 1**
  - This means OpenGL ES 2 and GLSL 1.2
  - Supported in all modern browsers
    - We officially recommend Chrome
- **We will use three.js on the Browser side**
  - a popular library providing matrix math, scene graph, convenience functions, etc.
  - You won't have to write code that uses three.js but it will help to understand how it works

Good reference materials

- the classic book
  - its website
  - Cornell library eBook
- lighthouse3d.com tutorials
  - GLSL 1.2 tutorial
  - Mozilla WebGL API doc
- Official material from Khronos standards organization
  - OpenGL ES 2 and GLSL ES 1.0 Specifications
  - OpenGL ES 2 / GLSL ES 1.0 Reference Card
  - OpenGL wiki

