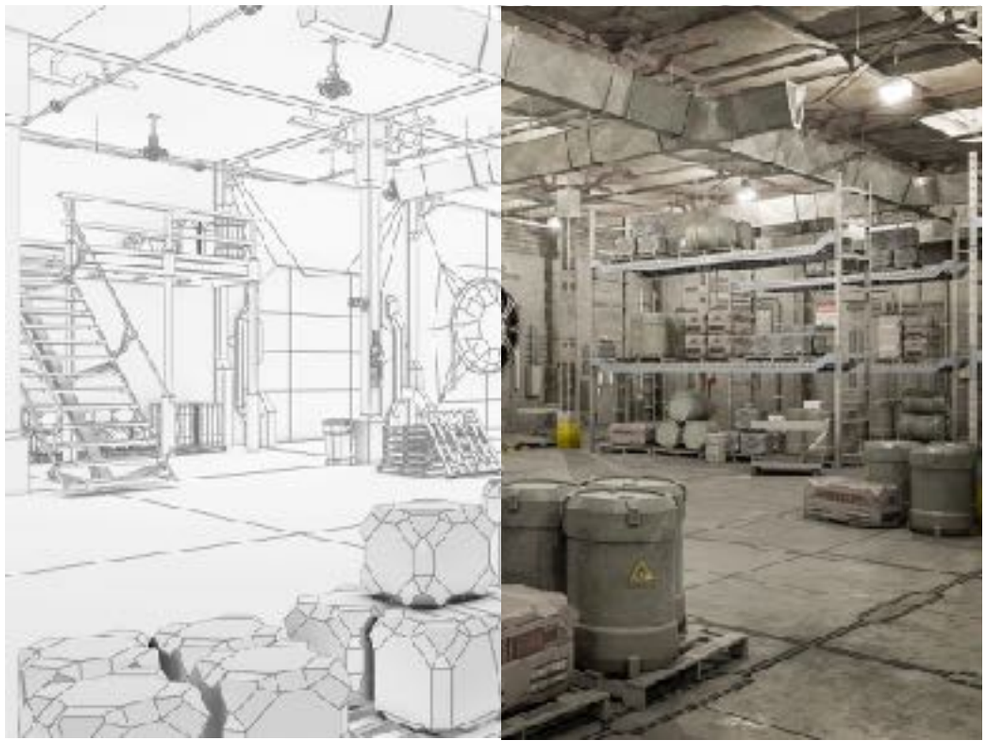
15-462: Intro to OpenGL

Adrian Biagioli

Graphics APIs

- A **graphics api** provides an abstraction over common rendering operations.
  - Important: **you don’t need a graphics API to do graphics!**
- Why use a Graphics API instead of writing it yourself?
  - GPUs are designed around them leading to massive speedups (this is what graphics drivers do!)
  - Standardization of Graphics APIs leads to better debugging and tooling (why DirectX is so popular!)
  - It takes way less time

Rasterization vs Pathtracing



Rasterization

Transform scene geometry via matrix operations to screen space, then use triangle fill algorithm.

Optimized for performance

DrawSVG (A1)

Pathtracing

Bounce simulated rays of light throughout your scene randomly for each pixel, and illuminate if it eventually intersects a light.

Optimized for realism

Pathtracer (A3)

Common Graphics APIs

- **OpenGL**: Runs on all platforms, but old, slow, and falling out of fashion. Mac support ending soon.
  - OpenGL ES: Subset of OpenGL for mobile GPUs
  - GL 1.1 != GL 2.1 != GL 3.3 != GL 4.6
    - **Massive** breaking API changes between GL versions — hard to find tutorials!
    - … and that's not even counting extensions!
- **Vulkan**: Modern Graphics API, runs on every platform (macOS needs a Metal wrapper)
- **DirectX**: Windows / Xbox only, very popular in Game development due to engine support and tooling
  - DirectX 9: Used on Xbox 360 / WinXP, similar to GL 2.x
  - DirectX 10: Used on Xbox 360 / Vista, similar to GL 3.x
  - DirectX 11: Used on Xbox 360 / Xbox One / Win7, similar to GL 4.x
  - DirectX 12: Used on Xbox One, similar to Vulkan
- **Metal**: Apple's low level graphics API for iOS / Mac

Choosing a Graphics API

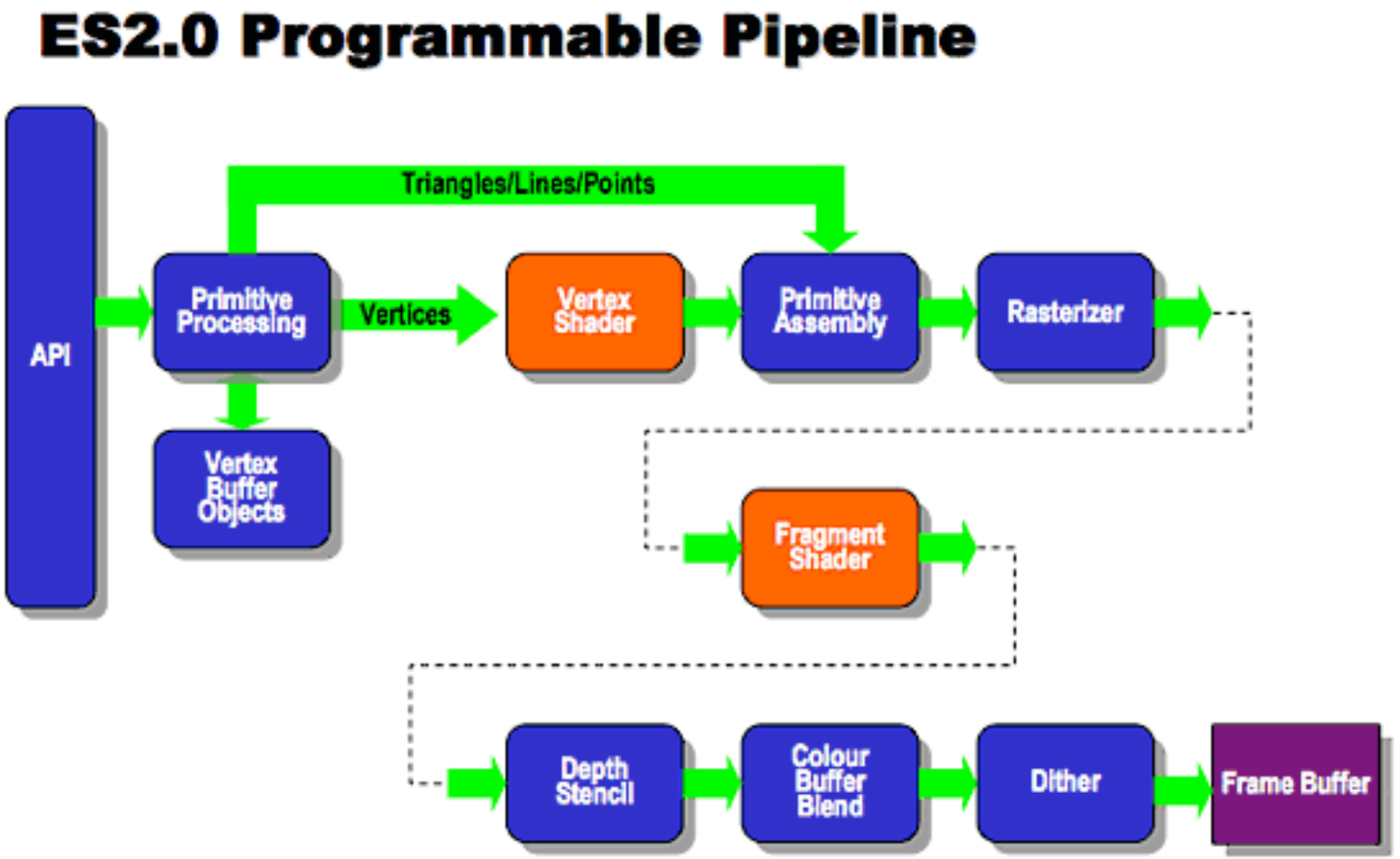
- The graphics API you should use depends on:
  - Platform(s) you are publishing on (including OS!)
    - Example: On Windows DirectX performs better than OpenGL due to driver support
  - Specific API Features
    - Example: Vulkan offers lower level control of GPU memory than OGL, but may be harder to use
    - Whatever new hotness comes out (cough *raytracing*) tends to take a while to arrive to all graphics APIs
  - Your own preference / familiarity
    - Much more important when considering shader languages

drawsvg

- 5% of the assignment: regurgitate this recitation in hardware_renderer.cpp
    - Everything we talk about today, up to blending
- 95% of the assignment: reimplement OpenGL calls in software!

Code!

OpenGL 2.x Render Pipeline



Wrap-up

- OpenGL and similar APIs are the bread and butter of practical computer graphics, so start learning them!
  - Recommend: 15-466 Computer Game Programming which uses OpenGL 3.3
    - Great tutorial for modern OpenGL: http://learnopengl.com
- Not mentioned today: **Shaders** are highly parallel code compiled for the GPU. Modern graphics libraries use shaders to implement many common GL 2.1 “fixed function” effects.
  - http://shadertoy.com (simple example here)
  - There is a shading language for all modern graphics apis

Example Code:

https://github.com/Flafla2/GLTutorial