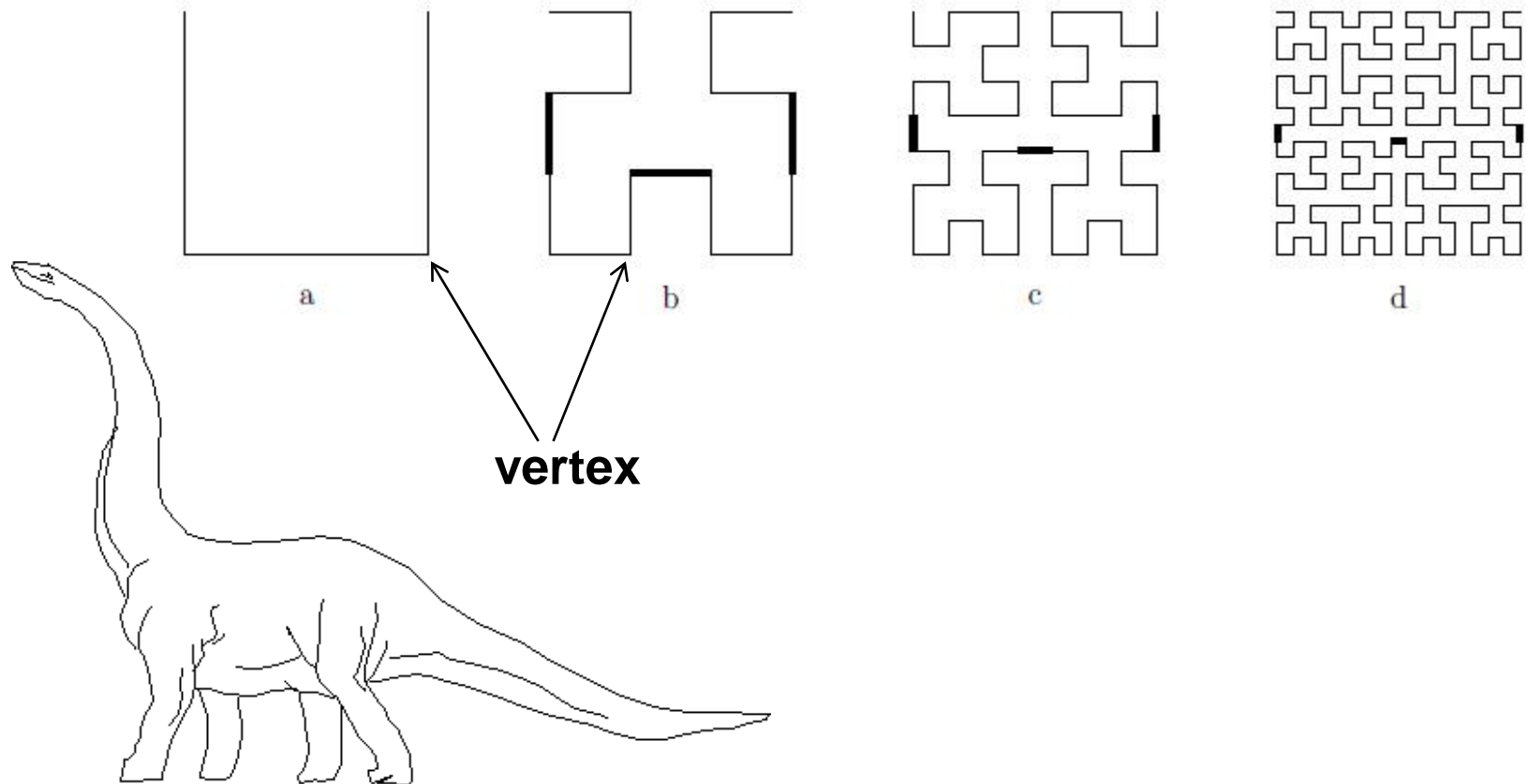# Elements of 2D Graphics

- **Polylines (vector graphics)**
- **Raster images (bitmap graphics)**
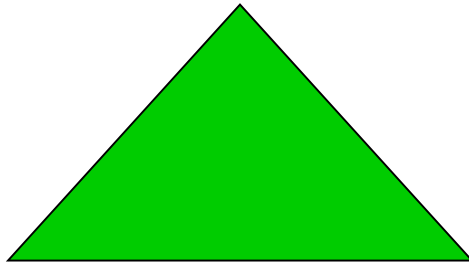
Elements of 2D Graphics
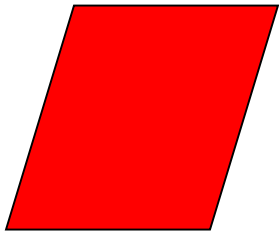
- **Polyline:** vertices (corners) connected by straight lines
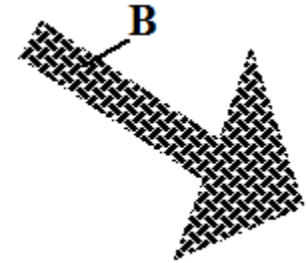- **Attributes:** line thickness, color, etc
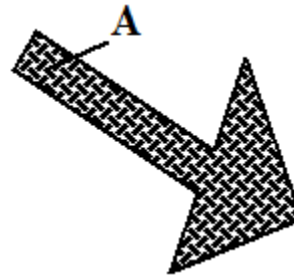
vertex

Filled Regions

- **Filled region:** shape filled with a color or pattern
- E.g: polygons

Polygons Filled with Color

Polygons Filled with Pattern

Raster Images

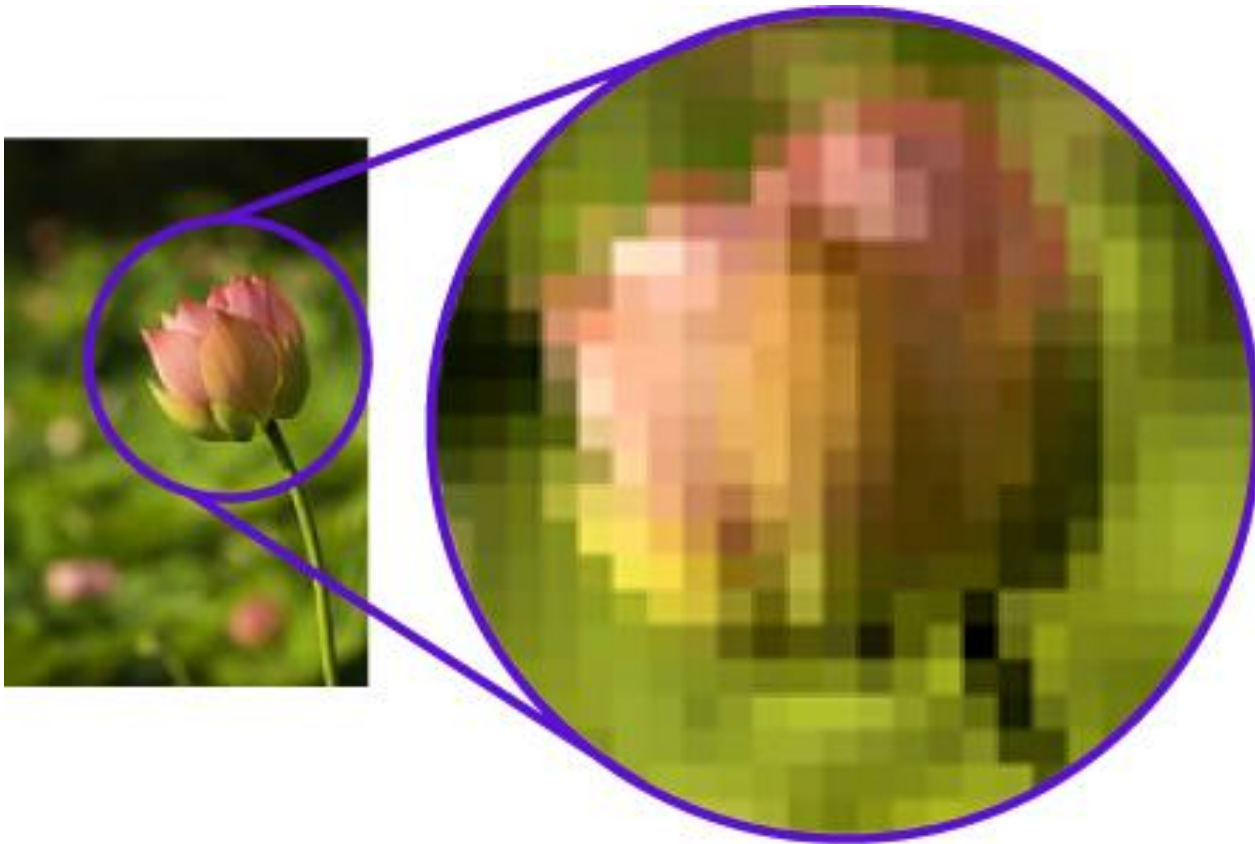- Raster image (picture): 2D matrix of pixels (picture elements), in different colors or grayscale.

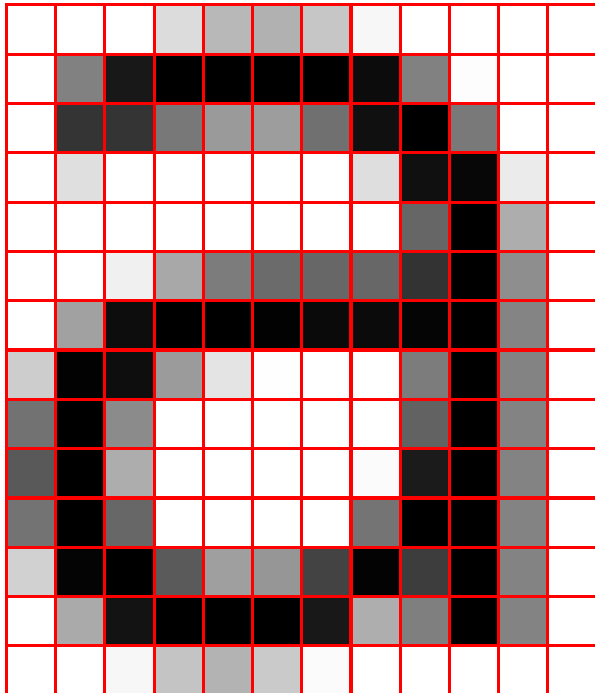
Grayscale Image

Color Image

Raster Images

Text

- **Text attributes:** Font, color, size, spacing, and orientation

Big Text

Little Text

Shadow Text

Distorted text

Rotated Text **Outlined text**

SMALLCAPS

Graphics Processing Unit (GPU)
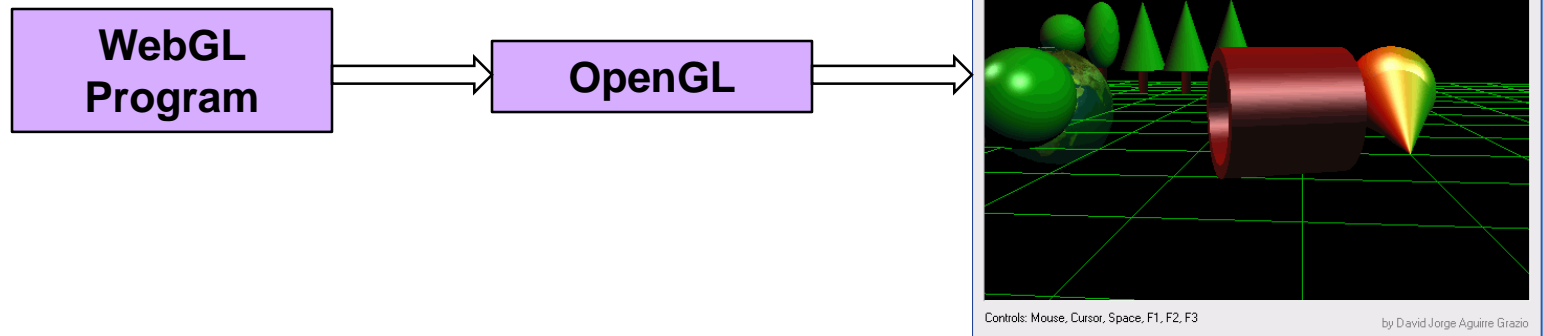

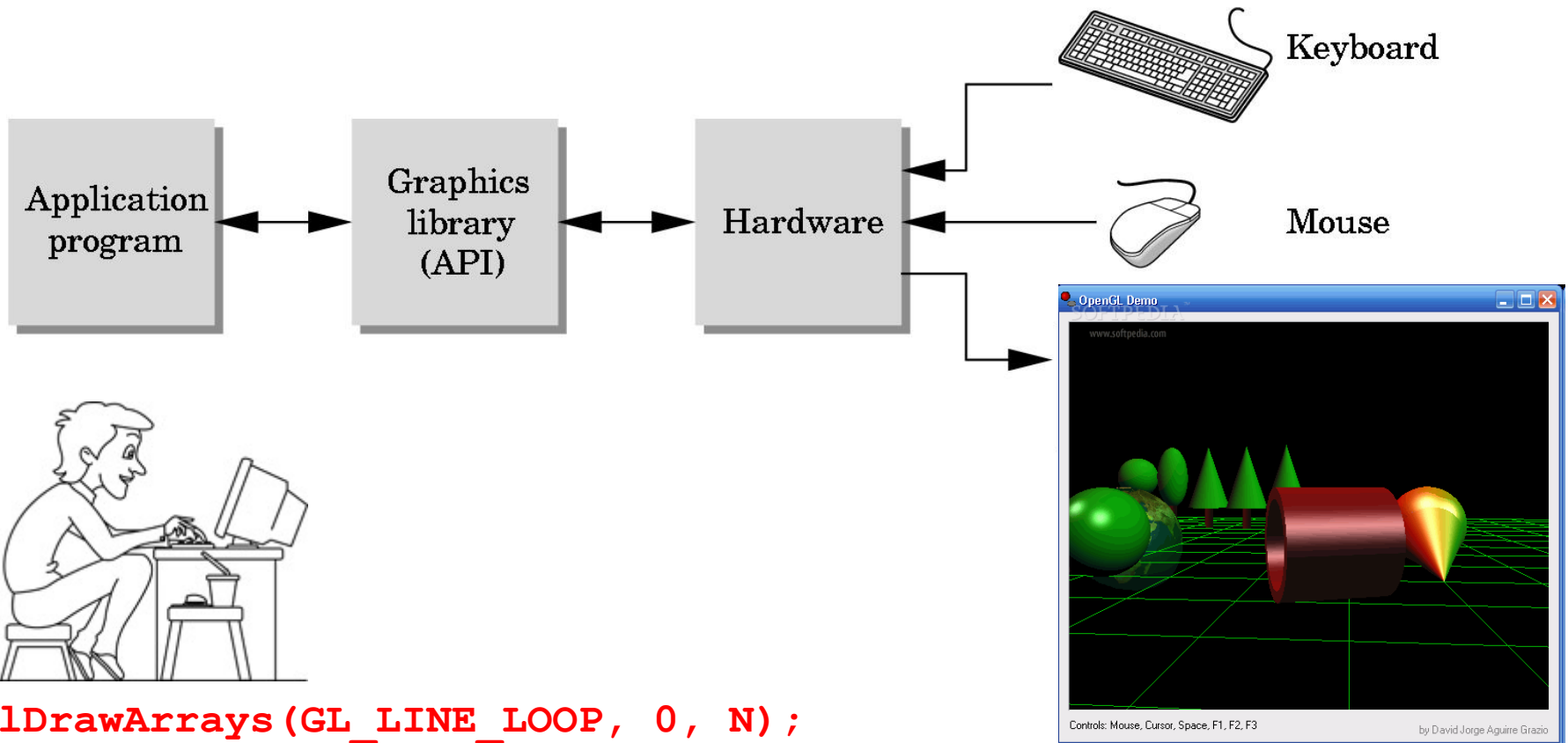**GPU on PC motherboard**

GPU on separate PCI express card

WebGL

- Web-based implementation of OpenGL
- Supported by most major browsers
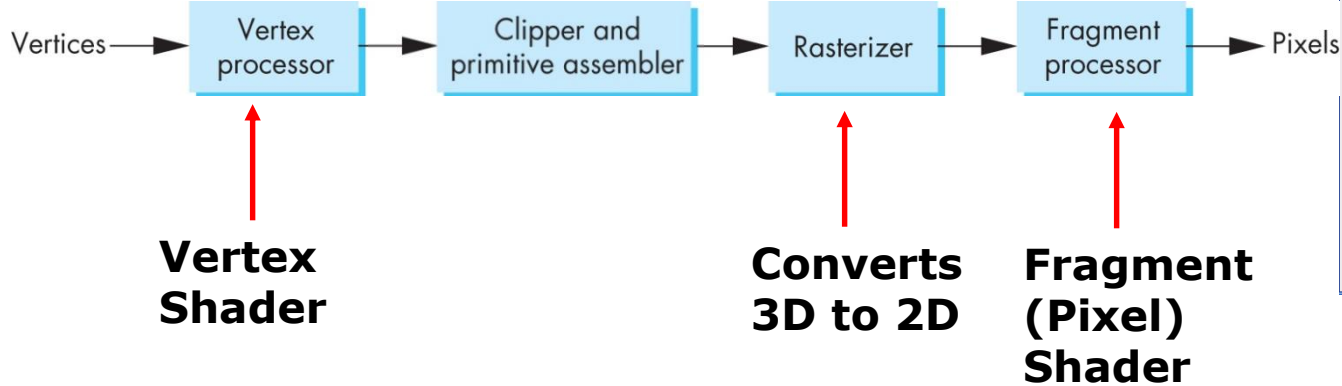- No additional software, compilation, etc. required

WebGL Basics


```
glDrawArrays(GL_LINE_LOOP, 0, N);
glFlush( );
```

Simplified WebGL Pipeline

Vertices → **Vertex processor** → **Clipper and primitive assembler** → **Rasterizer** → **Fragment processor** → Pixels

Vertex Shader

Converts 3D to 2D

Fragment (Pixel) Shader
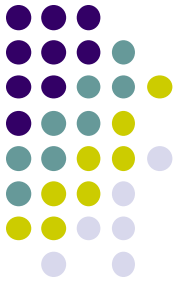
Vertex Vs Fragment

- **Vertex shader** code manipulates vertices of shapes
- **Fragment shader** code manipulates pixels

Vertex processor → Clipper and primitive assembler → Rasterizer → Fragment processor →

Vertices

Converts shape to pixels (fragments)

Fragments (pixels)