

# Computer Graphics & OpenGL

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Mines Linux Users Group

# Introduction

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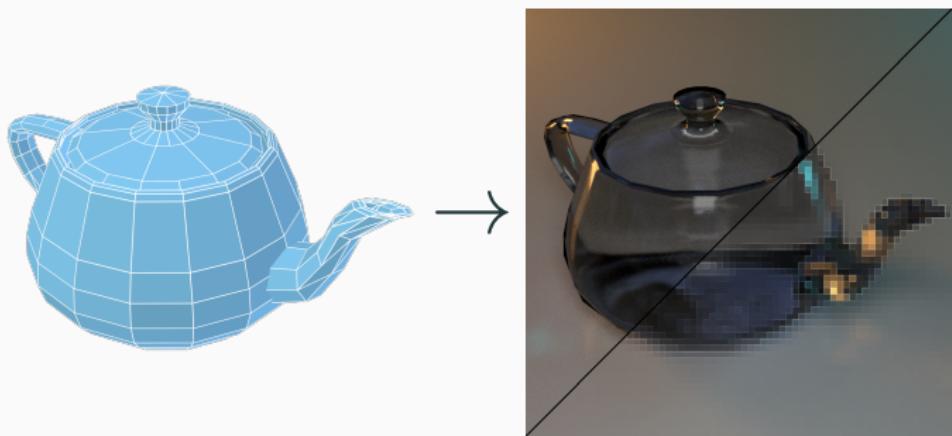
# Uses

Computer graphics is everywhere!

- Your terminal
- Web browsers
- Video games
- CAD software
- Movies, TV Shows
- Virtual reality
- Your bootloader
- QT, GTK+, wxWidgets
- Vim, Emacs, Notepad
- Embedded devices



# Definition



Computer graphics is the science of turning *shapes* into *pixels*.<sup>1</sup>

<sup>1</sup>Kindof, it can get more interesting than that

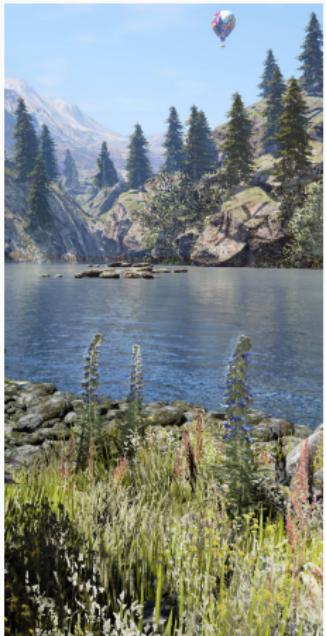
## Behind the Scenes

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# Realtime

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Realtime graphics use OpenGL or Direct3D to rasterize and shade triangular geometry on a graphics card/chip. Performance is very important due to the high framerate that is required for smooth gameplay/interactivity/animation. Lighting and materials focus on being "good enough" rather than on being truly accurate.



# UIs

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While they look different, UIs generally use OpenGL or Direct3D as well. Everything is still made of textured & shaded triangles. Anti-aliasing, text fidelity, etc. are all more important while lighting effects are generally absent. Responsiveness is key, but the frame can be updated as needed, not every 30th of a second.



# Offline

Offline graphics are used when the medium is non-interactive (movies, advertisements, etc). Because the available resources are limited only by budget and patience, offline graphics have unmatched fidelity. CPUs are often used instead of GPUs because this allows for more advanced calculations. However, this comes at a cost. Individual frames may take days to render.



# History

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# 1950s & 1960s

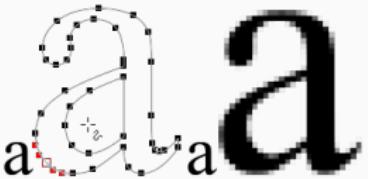
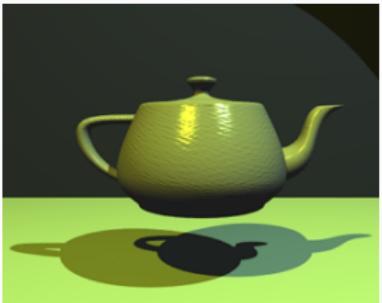
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- Military used computer controlled oscilloscopes to display strategic information
- Very simple graphical CAD programs and visualizers created
- Very first computer games
- Research into elementary 3D wireframe graphics
- Very early raster displays



# 1970s & 1980s

- Basic lighting models such as Phong developed
- Low-res, 2D games become commercially available
- CGI starts to be used in Movies such as 1982's *Wrath of Khan* and 1985's *Young Sherlock Holmes*
- Modern GUIs are developed
- High-quality digital typesetting becomes commonplace



PostScript type

Bitmap type

# 1990s & 2000s

- Fidelity and performance are immensely increased
- Personal computers, 3D video games, and GUIs become ubiquitous
- OpenGL and Direct3D standardize hardware graphics support
- CGI becomes commonplace in Movies, advertisements, and TV
- Global illumination and physically based rendering (PBR) techniques developed



# Today

- Given enough time, budget and expertise, offline graphics are photorealistic
- Particle and fluid simulations are extremely fast and accurate
- Realtime graphics make extensive use of shaders and PBR techniques
- UIs and offline graphics are increasingly GPU accelerated
- Linux and Mac have improved support for games and graphical software



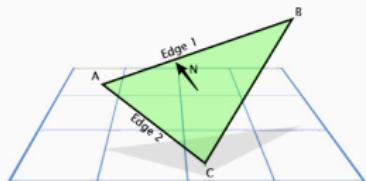
Fancy-pants-ery

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# Triangles

For the most part, modern computer graphics deal in triangles. This is because triangles have some nice geometric properties that other shapes don't:

- It is very easy to test if a point is within a triangle (barycentric coordinates!)
- A flat 3D plane can be drawn through any 3 points (a triangle)
- It is easy to calculate the direction a triangle is facing



# Textures

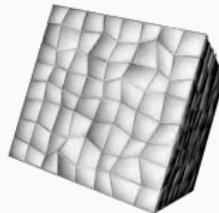
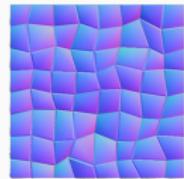
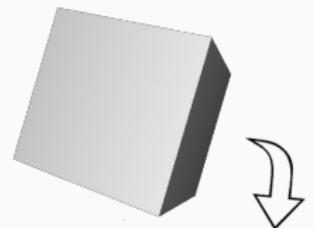
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- Textures allow for item



# Mapping

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# Phong

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# Painter's Algorithm

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# Depth

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# 3D Modeling

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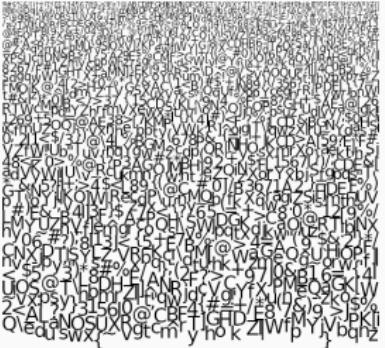
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# Text

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● ...



The image shows a large, dense block of text that appears as a solid black rectangle due to its small size and low contrast. It is composed of a grid of individual characters, likely ASCII or similar, which are too small to be legible individually but form a continuous pattern across the entire area.

# Sub-pixels

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# Multipass Rendering

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# Raytracing

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# Fresnel & PBR

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# Pathtracing

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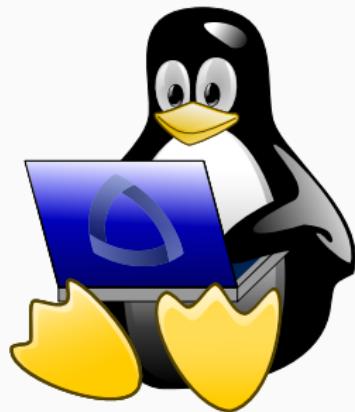
## Cool Stuff!

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