GPU Computing

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Mines Linux Users Group

The GPU

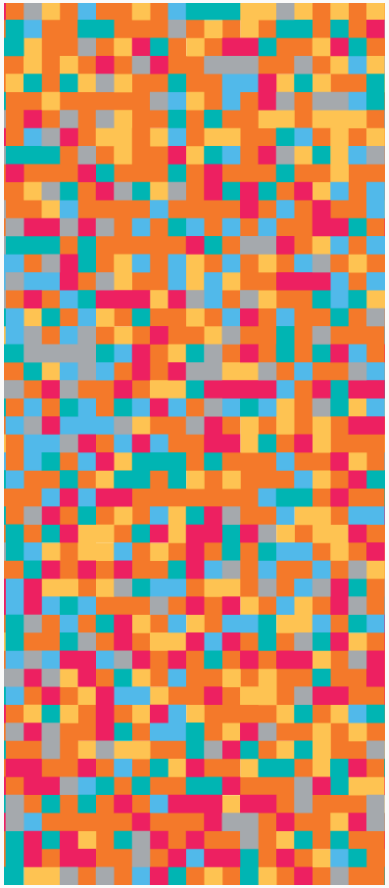
What is a GPU?

A Graphics Processing Unit (GPU) is a specialized chip primarily for accelerating graphical calculations.

GPUs generally derive their performance from their ability to do large numbers of identical arithmetic calculations in parallel.

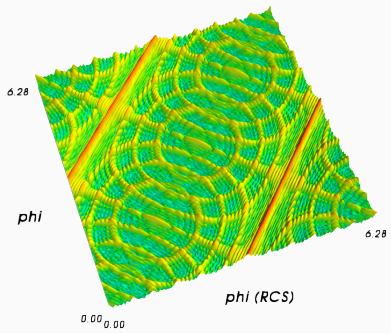
GPUs for Graphics

Screens have lot of pixels that need to be calculated very quickly. All of the required calculations are identical, just with different input numbers. And because pixels are independent the calculations are also trivial to parallelize. As a result, using the unnecessarily clever CPU would be wasteful and slow. A separate pixel-optimized chip can be used instead, leaving the CPU to do the important stuff.



GPU Computing

Coloring pixels is not the only problem that involves a large number of similar, repetitive calculations. General-purpose GPUs can be used for countless other problems including machine learning, computer vision, signal processing, statistics, linear algebra, finance, and cryptography.



History

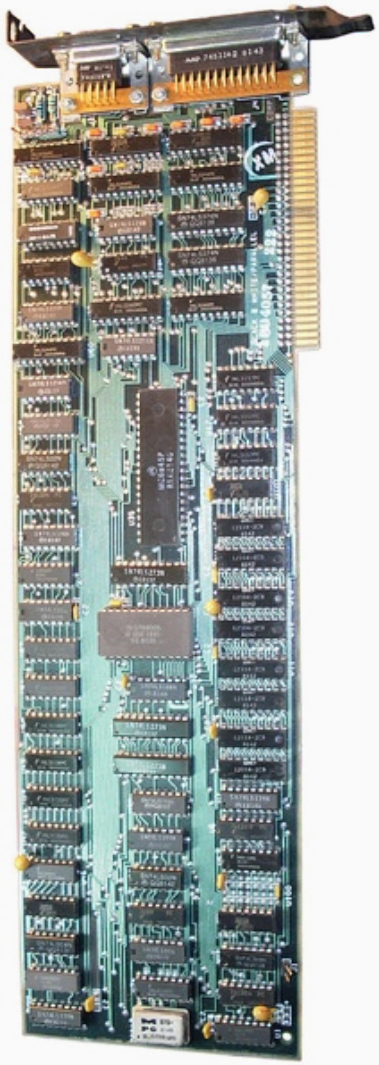
1970s - Highly specialized, used only for buffering video and drawing simple 2D rasters (sprites)

1980s - Common bitmap operations such as filling simple 2D shapes

1990s - 3D triangular graphics, common interfaces (OpenGL, Direct3D) developed

2000s - General purpose GPUs, capable of executing arbitrary instructions

2010s - Highly general, used as much for supercomputing as for graphics



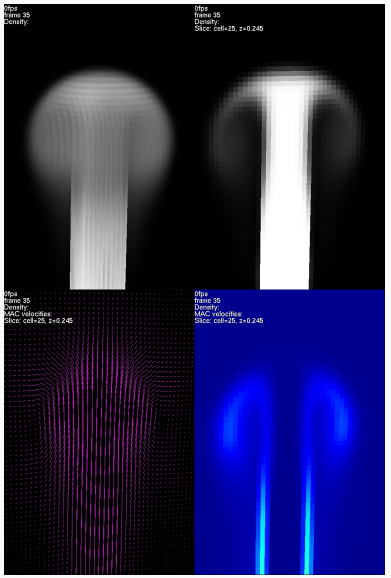
GPU Operation

Machine Learning

Computing At Home

OpenGL Shaders

Although shaders are used for pixel stuff, they are still fundamentally general purpose. Use vertex attributes, uniforms, and textures as input. Use the framebuffer for output.



OpenGL Shaders - Pros & Cons

Pros

- Shaders have been around since like 2004
- Universally supported
- OpenGL allows for minimal setup

Cons

- Low level
- Not very general
- All data has to be stored in textures/images

CUDA

CUDA is a computing platform and API that provides truly general GPU computing. C/C++/Fortran code can be compiled ahead of time or at runtime and sent to the GPU along with arbitrary chunks of memory.

Libraries for controlling and communicating with CUDA programs exist for many languages including C/C++ (through the CUDA SDK) and Python (PyCUDA library).

CUDA - Pros & Cons

Pros

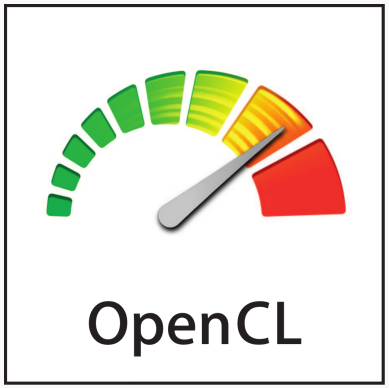
- Get to use real C/C++
- Pointers, recursion, etc.
- Copy arbitrary data between CPU and GPU
- Fast

Cons

- Only available on high-end Nvidia cards
- Very low level
- Annoying to setup

OpenCL

OpenCL is a cross platform alternative to CUDA. It is similar in structure to OpenGL, but intended for general-purpose computation (not just 3D graphics). Bindings exist for all common languages.



OpenCL - Pros & Cons

Pros

- Cross platform
- Nice API
- Will use CPU instead of GPU if needed (works anywhere)

Cons

- Must use C-like OpenCL language
- No recursion, pointers, etc.
- Slightly slower than CUDA

ArrayFire

Torch

TensorFlow

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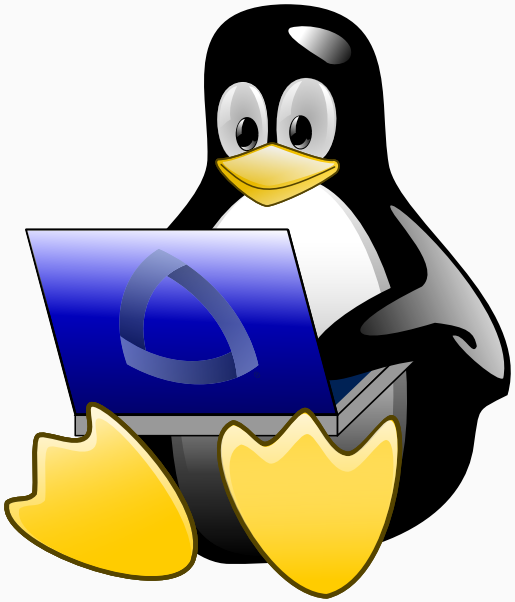

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